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A SURVEY OF POLYCHLORINATED BIPHENYLS IN AMBIENT AIR IN ONTARIO

PHASE II - VOLUME I

SAMPLING SITE SELECTION AND ANALYTICAL PROCEDURES

Final Report

Report ARB-011-81-ARSP

Ontario
Ministry of the Environment

The Honourable
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Minister

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Deputy Minister

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MOE Report-ARB-011-81-ARSP

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This report is part of a series of reports published by the Ministry of the Environment, Air Resources Branch - on the development of techniques for collection, detection and determination of Polychlorinated Biphenyls in ambient air and results of surveys performed in Ontario in the periods of Sept.-October 1979 and June 1981. The reports of this series are:

ARB-TDA-08-80-Phase I	-	Development of Laboratory and Field Procedures
ARB-011-81-ARSP-Phase II	-	Volume I; Sampling Site Selection and Analytical Procedures.
ARB-025-81-ARSP-Phase II	-	Volume II; Meteorological Correlation for the 1979 Survey of Polychlorinated Biphenyls in Air in Ontario.
ARB-026-81-ARSP-Phase III	-	1980 Survey of Polychlorinated Biphenyls in Air in Ontario.

This series of reports should be considered as a unit, and the individual members of the series should be evaluated in concert with the other members. This situation arises since this work was developmental in nature and the reports present a chronological picture of the work done over period of time on the sampling, sample processing and analytical procedures. The Phase III Report describes the current state-of-the-art for PCB sampling and analysis as developed by MOE Scientists.

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Part I

INTRODUCTION

Since 1970, the Ministry of the Environment has performed or initiated seven studies of PCB's in ambient air in Ontario. The first three studies were of a research nature and involved a rather limited number of samples. The first reported work in Ontario (1972) was done by G. Thomas (1) of the Ontario Research Foundation who measured PCB's in air, using ethylene glycol as a collection medium, in Hamilton and at Sheridan Park in Mississauga. Only a few samples were collected and analyzed by the gas chromatography-electron capture detector (GC/ECD) method. Reported concentrations ranged from approximately 12 ng/m^3 at Sheridan Park to approximately 99 ng/m^3 in Hamilton. The identity of PCB's in some samples was confirmed by GC/MS (gas chromatography/mass spectrometry). A similar study was reported in 1975 (2) with results of approximately 1 ng/m^3 in Sheridan Park, 2 to 8 ng/m^3 in Hamilton, and 1 to 3 ng/m^3 in Toronto. Again, in some of the samples, the presence of PCB's was confirmed by GC/MS.

A MOE survey carried out in 1976 (3) reported PCB's levels at several selected sites in Ontario: Hamilton 3 to 29 ng/m^3, Peterborough 2 to 10 ng/m^3, London 1 to 10 ng/m^3, Toronto 2 to 5 ng/m^3, Sarnia 4 ng/m^3 and Windsor 1 to 6 ng/m^3. The presence of PCB's was confirmed by analyzing each sample on two different GC columns, comparing the elution pattern and quantification in terms of mixtures of Aroclors 1242, 1248, 1254 and 1260. The more intensive surveys are listed in chronological order.

March 1977 Survey

The first intensive survey was performed in February - March 1977 (4) by the Air Resources and Laboratory Services Branches. Air samples were collected

1) Ontario Research Foundation Report 72-1 (October 1972)
2) Ontario Research Foundation Report 75-1 (August 1975)
3) Ministry of Environment of Ontario Report ARB-TDA-49-78 (1978)
4) Ministry of Environment of Ontario Report ARB-TDA-40-77 (1977)

in the vicinity of the St. Lawrence Cement Plant, Mississauga, and in the adjacent residential districts before and during incineration of PCB's in the cement kiln. PCB's from ambient air were preconcentrated on "Florisil" cartridges and after extraction and clean up, analyzed by a GC/ECD technique, with manual curve evaluation and quantitative matching to the elution pattern of commercial Arochlors. A total of 54 samples were collected and the reported concentrations were in the range of 0.1 to 6 ng/m^3 with no significant difference between the periods before and during the incineration. The average concentration for all 54 samples was 2 ng/m^3. An additional 17 samples were collected on the plant property, downwind of the storage and pumping area for PCB-containing oil. Values between 3 and 2300 ng/m^3 were measured, with the higher concentrations recorded during the unloading operation. The average concentration for the 17 samples was 400 ng/m^3.

May 1978 Survey

A second survey was performed by the Central Region and Laboratory Services Branch in May 1978 (5) at locations in residential districts of Mississauga identical with those used in the above survey. Sampling and analysis were performed in a similar way, with computerized elution pattern evaluation and matching to commercial Arochlors. During the survey, a total of 53 samples were collected. The results of the survey ranged from 2 to 40 ng/m^3 with no appreciable difference between the locations. The average concentration for the 53 collected samples was 14 ng/m^3. No attempt was made to eliminate the possibility of interferences by using a different analytical technique.

5). Don Ogner; Ontario Ministry of Enivronment, Central Region: private communication

June - July 1978 Survey

A later survey in Mississauga initiated by the Air Resources Branch was carried out under contract by the Ontario Research Foundation (6) during June - July, 1978. The residential sites of the previous survey were included in the seven residential sampling sites of this survey and in addition, four industrial sites were selected.

Preconcentration was done on "Florisil" cartridges (as in the previous surveys) with subsequent extraction and GC/ECD detection. The quantification was based on the predominant 16 PCB isomers, whereas in earlier surveys, the elution pattern matching method was used. A set of fourteen air samples was analyzed simultaneously by the Ministry of the Environment Laboratory Services Branch to evaluate the possible differences due to the quantification technique. The agreement of this interlaboratory study was well within the normal limits for such a comparison ($\pm$20%).

A total of 533 samples were collected during the survey and the average concentration for residential sites was 10 ng/m^3, and 18 ng/m^3 for industrial sites. The range of observed concentrations was from 0 to 120 ng/m^3, with no appreciable difference between most industrial property and residential sites when probable interferences were removed.

In order to improve the comparative data base of typical concentrations of airborne PCB's in areas of Ontario outside of Mississauga, the Air Resources Branch carried out a province - wide survey for a period of 28 days in September and October of 1979. A total of 25 sites were selected; the sites were typical of industrial, urban, suburban and rural land use in Ontario. A detailed description of the sites is given in the following section of this report.

6). Ontario Research Foundation Report No. P-2818/G (revised)-01 (1978)

SAMPLING SITE SELECTION AND DESCRIPTION

1. Selection

In order to achieve the objective of the survey in measuring typical background concentrations of PCB's in ambient air, the sampling sites were chosen according to the following criteria;

(a) To achieve a suitable mix of different land usage, the 25 sites were distributed as follows: urban (13 sites), suburban (3 sites), rural (6 sites) and industrial (3 sites)

(b) The sampling site had to be a minimum of 2 blocks away from any localized sources of PCB's known to the Ministry of Environment including:

(i) electrical power and switching stations

(ii) transformer storage facilities

(iii) industrial facilities using pumps/gas transmission turbines

(iv) municipal pumping stations

(v) storage and handling areas for PCB's and PCB -containing material (eg. capacitors, PCB contaminated oil, etc).

(vi) municipal landfill sites formerly used as disposal sites for rejected capacitors and other wastes containing PCB's.

(vii) any facility or institution with electrical transformers or capacitors on site.

(c) If the sampling site was a minimum of 2 blocks from a potential source - (item (b) above) - local meteorological conditions were evaluated and the sampler was positioned upwind of the potential source in relation to the predominant wind direction across the site.

(d) The site must have an AC power outlet to operate the sampler.

(e) The site should be sufficiently accessible so that it can be visited once a day to exchange the sampling cartridge and for possible use during the winter.

(f) The site should be reasonably secure against vandalism or tampering with the sampler operation.

(g) The samplers were installed on flat - roofed buildings or in open areas.

(h) The sample inlet was 2 - 3 feet above the sampler in all cases.

2. Description

A total of 25 sites conforming to the criteria were ultimately chosen. Table 1. lists the sites as to the location, and site coding for unequivocal identificaton of collected samples.

SAMPLING EQUIPMENT AND PROCEDURE

The sampling equipment used was a low volume "Nutech" gas sampler Model 221 AC/DC. A schematic of the sampling train is shown in Figure 1. Specifications of the instrument are:

Physical:	Dimensions - 15 1/2"W X 14 1/2"H X 11"D Weight - 35 lbs. Cabinet - 0.090" aluminum Base - 0.125" aluminum Sky-blue epoxy finish.
Power:	110 V, 60hz AC or 12V DC Model 221-1A14 draws 2.0-2.5 Amps, depending on flow rate (Max, 60 Amp.hr/day) Built in battery charger. Recharge time equals approximate running time.
Gas Flow:	Max. flow-rate: 10-15 liters per minute. Flow rate, adjustable with flow-control valve from 0.5 to 10 liters per minute, measured by rotameter. Digital readout dry gas meter measures total volume sampled to max. 10,000 cu. ft., with readability to 0.001 cu. ft. Max. vacuum: 20-24 in. Hg. Vacuum gauge monitors pressure drop across cartridge.
Sample Inlet:	1/4" Quick Connect in upper side, for easy mounting of GC cartridge holder or other suitable sampling connections. Currently available MOE units are equipped with copper tubings and appropriate fittings for airtight connections of cartridges.

Note: Mention of brands of trade names in this document does not constitute endorsement by the Ministry of the Environment or the Government of Ontario.

The dry gas meters were calibrated before use at the Air Resources Branch using a wet test gas meter and found to measure the volume within $\pm 5\%$.

The sampling cartridges contained approximately 5g of "Florisil" held in a glass tube as detailed on pg. 8. Twenty-four hour integrated samples were collected on a daily basis; each sample corresponding to a total volume of 10 to 15 m^3 of ambient air.

CARTRIDGE PREPARATION

Cartridges used for the field collection of PCB's were manufactured in accordance with a design previously published (7). The design consisted of 16 mm OD threaded glass tube with a 1/4" glass tubulation used for connection to the "Nutech" samplers. The contents of the tube were sealed and held in place during shipment by use of a 1/4" glass rod through the cap and "Teflon" sealing ring. The end, which was connected to the sampler, was sealed with a piece of 1/4" FEP tubing, which had been previously formed to fit by softening it with a heat gun and slipping it over the end of the cartridge. The same piece of tubing was crimped (with a pair of pliers) and heat sealed to provide a leak-tight seal for the cartridge.

The field sampling cartridges were prepared following the procedures outlined in the MOE Report ARB - TDA - 08-80 Appendix 1. "Florisil" (30/60 mesh) which has been proven adequate for this purpose by many other workers including MOE personnel was used as the absorbant for PCB's. A 5.0 cm bed of "Florisil" was used in the cartridges and was held in place using glass wool in both top and bottom. All materials and components used for the preparation of the cartridges were proven clean prior to use. All glass components were washed, rinsed copiously with nanograde acetone, then pentane, and baked at 250°C overnight. The baked glassware was subsequently rinsed with pentane and the pentane rinsings collected, concentrated and analyzed for PCB's. The Florisil (30/60 mesh) used was thermally cleaned and proven to have a suitable blank level before use.

7) Ministry of Environment Report ARB-TDA-51-78 (1978)

The cartridge consisted of the following:

- precleaned stainless steel screen
- 0.5 cm of precleaned glass wool
- 5.0 cm of proven "Florisil" (30/60 mesh)
- 0.5 cm of precleaned glass wool

Prepared cartridges were subjected to a further cleanup to eliminate any residual contamination. Batches of ten cartridges were eluted with 200 ml of 10% methylene chloride in hexane, then with 200 ml of pentane. The last 30 ml of pentane from each of the cartridges was collected and combined. This combined extract was reduced in volume and analyzed for materials which would interfere with subsequent PCB analyses. Residual solvent was removed by a stream of "Florisil" filtered air passed through the cartridges. Cartridges were subsequently reactivated by heating in an oven at 135°C for two days. Prior to shipment of these cartridges into the field, one cartridge from each batch was removed and treated as a sample. The subsequent analysis confirmed that the batch of cartridges was still suitable for use. Each cartridge was sealed as described and placed in a glass culture tube with a plug of cotton wool to protect each end of the cartridge.

Results of the final blank assays are summarized in Table 2. On average, the cartridges shipped had a blank assay equivalent to 0.35 ng PCB's/m^3 air.

SHIPPING AND RECEIVING

Cartridges which had been accepted for use were labelled with a tag wired to the neck identifying the cartridge by its batch number and providing a place to write a field sample identification number . Each cartridge was contained in an individual glass culture tube and was immobilized by cotton wool in top and bottom, and sealed with a cork.

Cartridges were shipped out in groups of nine. This corresponds to a period of sampling of one week; one per day with two additional tubes to be used as field blanks, or, if necessary, as replacements in case of breakage.

Shipping was handled from the contractor's laboratory site, using commercial carriers. The cartons, one for each sampling site, were sent to the appropriate regional Ministry office for further distribution to field personnel. In a few cases, involving Central Ontario sites, shipping and sampling was handled by the contractor and/or subcontractors involved in the project.

Sampling cartridges were shipped out in four lots on a weekly basis. Cartridges were returned immediately after the week's allotment was used up. The same shipping cartons were used for return of the cartridges and, again, commerical carriers were used.

Field personnel also received field data sheets and shipping labels which were included in the cartons. Field data sheets were used to record sample volume, temperature, and pertinent meteorological data and to report any indication of instrument or operator malfunction.

GENERAL ANALYTICAL PROCEDURES

GLASSWARE PROVINGS

In order to analyze the very low levels of PCB's to be encountered, it was necessary to ensure that all glassware was as clean as possible. Prior to its use for the clean up and extraction of samples, all glassware was proven to be clean by GC and had a residual blank equivalent to less than 1 ng/m^3 of PCB's per set of glassware. Details of the clean up and proving procedures are given in MOE report ARB - TDA - 08-80 .

Briefly, all glassware was handled (in expanded metal mesh baskets) in batches of ten sets thoroughly rinsed with nanograde solvents (acetone, then hexane) and baked at 250°C in a forced air oven, overnight. These glassware ovens were used for no other purpose. When required for use, the glassware was removed from the oven and allowed to cool to room temperature. The glassware was first rinsed with nanograde hexane, then with nanograde pentane. The pentane rinsings were collected in one of the 500 ml "Kuderna-Danish" evaporators which was being processed and subsequently reduced in volume to 1.0 ml, using 1.0 ml iso-octane as a keeper. The rinsing concentrate was analyzed by GC. A glassware batch was accepted for use only if the analysis was less than 1 ng/m^3 on average for each set of glassware (based on an assumed 10 m^3 air sample).

During the course of Phase II, it was realized that glassware was being accepted on the basis of 1 ng/m^3 PCB's for the total batch of glassware. This turns out to be a more stringent test of cleanliness than was required by a factor of ten.

A summary of the results for these glassware provings is given in Table 3. On average, the glassware used showed residual contamination which was equivalent to 0.029 ng/m^3 of PCB's; a factor of thirty times less than our criterion for a set of glassware.

CARTRIDGE EXTRACTION AND CLEAN UP

Ambient air samples which were collected onto "Florisil" sampling cartridges were extracted and prepared for analysis, utilizing procedures described in MOE Report ARB - TDA - 08-80. All samples we prepared and sealed into glass ampoules and labelled for subsequent analysis.

Each set of samples prepared on a given day was accompanied by a binder containing record sheets for each sample. The identification tag on the field sampling cartridge was cut in half; half being stapled to the appropriate sheet and the other half remaining on the sample to identify the cartridge.

A glass solvent reservoir was placed on the cartridge in place of the glass rod used to seal the cartridge during shipment. The PCB's were extracted by elution with 200 ml of nanograde pentane, directly into the "Kuderna-Danish" reservoir used for evaporation of the solvent. The sample was (carefully) reduced in volume to 0.5 ml and subjected to cleanup by using 3% water deactivated "Florisil" (100/200mesh) and elution with pentane. Fourteen millilitres of pentane were collected (a volume previously shown to quantitatively recover all PCB isomers) in a graduated receiver modified to accept a "micro-Snyder" head. Again, the sample volume was reduced to 10 ml by careful evaporation. The sample was split into two 5 ml portions, one of which was sealed in a glass ampoule for further analysis at MOE-LSB . The second portion was then reduced in volume to 1.0 ml, utilizing iso-octane as a keeper and sealed in a glass ampoule for subsequent GC analysis (samples were placed in "Teflon" lined screw cap vials if immediate analysis was possible).

Recovery checks were also run along with the first set of samples extracted during the day. Blank cartridges which had been supplied to MOE-ARB were spiked with an unknown quantity and composition of PCB isomers. One of these

cartridges was extracted and treated as a sample each day. In addition, an analytical blank (200 ml of nanograde pentane) was processed as a sample extract, and a recovery check (consisting of the PCB isomer calibration mix spiked into 200 ml of pentane in a "Kuderna-Danish") was incorporated into an overall scheme of quality control used during this project.

Quality control cartridges supplied by MOE-ARB personnel were spiked with a multicomponent mixture of PCB isomers (typically eleven). Six different mixtures were used. The amount of PCB spiked on the cartridges ranged from less than 100 ng to 450 ng total. The recovery (Table 4) of all isomers ranged from a low of 34.9% to a high of 182.5%, with an overall average recovery of 83.8% (SD = 31%).

Internal recovery checks performed by the contractor were of a different nature. An aliquot of a PCB isomer mixture was spiked into 200 ml of pentane in a "Kuderna-Danish" evaporator. Only two different mixtures were used during the project. The first mixture was of the same composition as the mixture used for calibration of the gas chromatograph (spiked at 796 ng). The second mixture (spiked at 156 ng) consisted of eight isomers, seven of which were previously shown to be late eluting components in the "Florisil" cleanup. The eighth component was readily eluted and could function as an internal standard if needed. The total recovery ranged from a low of 55.5% to a high of 141.7% with an overall average recovery of 87.9% (SD = 18.7% abs). No significant change in overall recovery was noticed due to the change of the standard used to test the recovery, although the standard deviation increased slightly from 13.0% abs. to 21.2% abs., reflecting the fact that the isomers contained in the second mixture are retained on the "Florisil" cleanup column to a greater extent. Results are shown in Table 5.

Analytical blanks were obtained as previously indicated, and results are shown in Table 6. As expected, due to the low levels of the blanks the variability

of these results are high. On average, the result of 12.1 ng/ml meets the criterion of 20 ng/ml (equivalent to 1 ng/m^3). The criterion was met 32 times out of 40 (80%). Problems which led to the higher results (such as solvent contamination and/or contamination of the cleanup "Florisil") were eliminated as encountered. Results which met the desired criterion were very low; 3.1 ng/ml on average, and indicate that, if contamination problems occurred, they tended to be quite dramatic and sudden.

All of the results tabulated in Tables 3, 5 and 6 were obtained using the packed column gas chromatography.

PACKED COLUMN RESULTS

A summary of results of analysis of cartridges used for air sampling which were analyzed prior to the decision to analyze all of the samples by capillary gas chromatography are given in Appendix A.

Data for each site are presented on one page. The data are expressed in ng/ml of final iso-octane extract. Ambient air concentrations (ng/m^3) would be an approximate factor of 5 times less. Three columns of figures are presented. Under the column labelled "assigned" is the concentration figure which results from the sum of all concentrations of component peaks in the sample chromatogram whose retention time occurred within a two percent window of the retention time of a PCB isomer in the calibration mixture. Under the column labelled "manually assigned" is the concentration figure which results from the sum of all other peaks in the sample chromatogram, which are quantitated based on the calibration isomer adjacent to it which was of the lowest detector sensitivity. The third column is the total of the two previous columns.

No further interpretation of these figures has been undertaken since it was realized that the packed column analysis significantly overestimated the levels of PCB's present in the sample.

PACKED COLUMN METHODS

The gas chromatographs used for analyses were Varian 3700's, fitted with dual electron capture detectors. One instrument was fitted with a Varian Model 8000 autoinjector to permit continuous analysis of sample extracts overnight and during the weekends. The autoinjector was set up to automatically rinse the syringe and sampling lines with solvent immediately following injection of a sample, thus minimizing

absorption of and cross contamination of samples. A sample and wash flush volume of 150 ul was used. Varian CDS-111 Chromatography Data Systems were used on each channel for digital integration of the detector outputs and partial data reduction, and were set up to perform external standard calculations and provide results expressed in concentration units of ng/ml in the final sample extract.

The following analytical conditions were used throughout Phase II for the screening analysis of PCB's.

Column - Glass Coil 4 m x 2 mm ID x 6 mm OD

Packing - 1% "Dexsil 400" on "Anakrom A" 90/100 mesh

Injector Temp	190°C
Detector Temp	260°C
Column Temp	160°C 4 min.
Program	1°C/min. for 29 min.
Program	4°C/min. Hold at 220°C

Carrier Gas Flowrate - Ultra Pure Nitrogen - 17.5 ml/min.

A constant injection volume of 5.0 ul was used. Manual injections were performed using the solvent flush technique. The autoinjector, used on Channel A only, was set up as described to ensure minimal sample cross contamination.

The above conditions were developed during Phase I (MOE Report ARB - 08-80) in which analytical conditions were sought to maximize the resolution of PCB isomers on packed columns and to minimize the background due to column bleed since temperature programming was to be used.

Routine monitoring of PCB's in ambient air samples required the use of the electron capture detector for this analysis because of its high sensitivity and its relative ease of use. Because of the wide response range of the electron capture detector to various PCB isomers and the complexity of the environmental samples, a

multicomponent mixture of PCB isomers was used as a calibration standard. The method of choice was to use a mixture of known isomers for calibration of the detector and subsequent calculations, rather than using commercial PCB mixtures (Arochlors) as a standard.

The selection of the isomers used for the calibration mixture was based on the desire to ensure that the mixture would model as closely as possible those isomers which were likely to be found present in the atmosphere. The criteria which were applied for selection of the isomers which comprised the calibration mixture are described in detail in Appendix A of the MOE report ARB - TDA - 08-80 and resulted in a mixture which is shown in Table 7. The nature of the analytical system used (the resolution and selectivity of the column) would have an effect on the isomers chosen for the calibration mixture and in this case was based on our column system and temperature program.

Due to the limited number of commercially available pure PCB isomer standards and the resolution of the analytical column, not all peaks which appeared in the sample chromatograms could be directly compared with a calibrated peak. For example, 2,4'-dichlorobiphenyl, a major component of commercial Arochlors, was not available as a pure isomer at the time this work was undertaken.

The packed column analysis was undertaken to screen the samples to determine which contained significant levels of PCB and should undergo a more detailed analysis by capillary column GC analysis, perchlorination analysis, or gas chromatography/mass spectrometry. Sample chromatograms were compared to the standard calibration chromatogram in a manner which would produce an absolute upper limit PCB concentration. All peaks whose retention time occurred between the retention times of the first and last components in the calibration chromatogram were considered to be due to PCB isomers, whether or not it actually was a PCB isomer. A 2% retention-time window was used for comparison of sample peaks against the calibration mixture peaks. If a peak did not fall within 2% of the retention time of an

isomer in the calibration chromatogram (a window is indicative of the reproducibility of the analytical system) then its concentration was calculated based on one of the two adjacent calibration isomers, whichever had the lowest sensitivity.

Monitoring of the instrumentation used was an integral part of an overall quality control program and this program ensured that the instrumental assay was adequate at all times during the survey. The quality control program included the monitoring of the following aspects:

- daily monitoring of instrumental operating parameters (gas chromatographs) to ensure constant operating conditions.
- daily recalibration of the instrumental sensitivity by injection of PCB isomer calibration mixture.
- weekly monitoring of the linearity of the instrumental assay by injection of three concentration levels of a PCB isomer calibration mixture.
- weekly monitoring of the reproducibility of the instrumental assay by a total of five injections of a PCB isomer calibration mixture.

The results of these checks were monitored on a continual basis. In addition, an audit of at least 10% of the samples analysed, reconfirming all aspects of the calculations, was performed by an external consultant.

Three columns with ECD detectors were in use during this project. Summary results of the quality assurance monitoring indicated above are given in Tables 8 to 16. Two channels were in continuous use for a 2½ month period. The columns in each of these channels were changed once during this period. The third channel was used for a one-month period and the column remained in use during that period. The summary calculations do not account for the change in columns on the A and B channels and the somewhat higher % standard deviations reflect this, relative to channel C data. The data in Tables 8, 9 and 10 are summary of the retention times for each isomer in the

calibration mixture and the average calibration factors for each isomer generated using the single point calibration performed each day. Calibration factor was defined in Varians' CDS-111 operation manual as:

$$\text{Cal Fact (i)} = \frac{10{,}000 \times \text{Conc (i)} \times \text{Scalar (i)}}{\text{Area (i)}}$$

The scalar factor used was equal to one in all cases and concentrations were expressed in ng/ml. Reproducibility of retention time ranged for the three channels from:

±6.2% to ±2.2% on channel A

±4.6% to ±1.4% on channel B

±1.3% to ±0.4% on channel C

Calibration factors were not as reproducible as the retention times. Reproducibility ranged for the three channels from:

±34% to ±327% on channel A

±39% to ±347% on channel B

±15% to ±107% on channel C

This data illustrates the difficulties that were encountered in trying to get the three GC systems working in an equivalent manner. Although the retention times were stable and the peak size was relatively constant (i.e. instrument sensitivity), the columns exhibited a highly variable baseline noise level which significantly affected the ability of the data reduction systems to detect or correctly integrate peaks early in the chromatogram which are comparatively small and those which occured late in the program where the baseline drifted significantly due to the temperature program. Unlike the data for retention times, the large average deviations are not totally due to the change in columns for channel A and B, but due to changes in noise level, which result from the use of packed column with a low loading phase. Although all due care was exercised in packing, conditioning and use of the columns, it proved difficult to obtain columns which would provide consistent operation and resolution which was originally thought to be adequate for the purpose. The column in channel C, although

operated over a shorter period, proved to be more stable and permitted more consistent peak detection and area determination.

The reproducibility of assay was similarly affected. Overall results of precision checks are give in Tables 11, 12 and 13. The results demonstrate the same trends previously indicated; early peaks or those late in the chromatogram are less precise in their area determinations. The results on channel B show higher variability due to a consistently higher baseline noise level.

Linearity of assay was determined by additional injections of the same PCB isomer calibration mixture diluted by a factor of two and five times. A least squares determination of best linear fit was performed on the results of these two determinations and the main result of the precision check.

A summary of average results determined using least square fits are tabulated in Tables 14, 15 and 16. The values of the slope determined by the linear regression fit generally agree with the values of calibration factor determined by the CDS 111 (note that the CDS 111 includes a factor of 10^4). More notably the variation in the determination of the slope is smaller than the variation in the calibration factors when monitored over the same period, particularly for those components which showed highest variability of the calibration factor. The intercept values which show much higher variability are equivalent to the detection limits for the indicated isomer. The variability of a determination at this concentration would be quite high.

This data analysis has been based on the results of the calibration with a multi-component standard mixture selected to resolve on the analytical column. A real air sample with an interfering matrix would increase the minimum detectable concentration, and positively bias the results, if the matrix were not resolved. Both of these effects were noticed when the results of a few packed column assays were compared with capillary column assays performed at MOE-ARB. Major peaks in the packed column assay were resolved on capillary columns into multiple peaks and only

a minor component subsequently proved to match the retention time of a PCB isomer. As expected, the capillary column analysis showed that the air sample is an extremely complex mixture and the numerous components made it difficult for the CDS 111 system to operate reliably on the packed column chromatogram. Consequently, except for the major peaks, the area integration in a real air sample was unreliable. The overall effect was that the resulting packed column assays were high compared to capillary assays by a factor of 20 to 60 times.

It was felt that the packed column assay, which was to serve the purpose of screening samples for subsequent analysis by capillary column GC and confirmation by perchlorination, was not adequate for the purpose. Subsequent work has indicated that the capillary analysis could be performed at a rate equivalent to packed column analysis. Although this does not take full advantage of the inherent capability of the capillary columns for high resolution, it was ample to alleviate the problems encountered with the packed column, and to provide realistic results.

PART II

INTRODUCTION:

During the previous work on monitoring and detection of Polychlorinated Biphenyls (PCB's) in ambient air, the limitations of the widely used gas-chromatographic methods with packed columns and quantification based on the characteristic fingerprints of commercial "AROCHLOR" mixtures were soon realized. These methods (9,10,11) assume that:

a) The ratio of individual PCB's in the vapour phase is identical or at least very close to the ratio in the liquid phase.

b) The ratio of the PCB's does not change after exposure to biological or ambient environment.

c) All interfering compounds can be removed from the sample during the clean-up procedure and if any stay in the processed sample, they get resolved and thus the PCB peaks can be identified and quantified with a high degree of confidence.

d) If the fingerprint resembles a mixture of two or more commercial "AROCHLORS" in an unknown ratio, a new standard can be easily synthesized by mixing commercial "AROCHLORS" to match the fingerprint and enable quantification.

The fingerprint of a commercial "AROCHLOR" may change after exposure to the environment and may not resemble the fingerprint of the original "AROCHLOR" (12,13,14). The distribution patterns of PCB's in ambient air can also be altered because of the differences between the volatilities, solubilities, chemical and physico-chemical reactivities of the individual components of the

9) Assoc. Off. Anal. Chem. Methods 29.018
10) Sawyer L.D., J. Assoc. Off. Anal. Chem 61, 272, (1978)
11) Sawyer L.D., J. Assoc. Off. Anal. Chem., 61, 282 (1978)
12) Lewis, R.G., U.S., National Bur. of Stds Special Pub. 422 P. 18
13) Fries, G.F., Environ. Health Persp. 1, 55 (1972), Published by National Institute of Environmental Health Science, N.C., U.S.A. Ibid P. 10
14) Cook, W.J., Ibid P.10

original mixture. (The limited number of physico-chemical data published is of questionable quality). The fact that PCB's may be photolytically degradated has been proven (15,16). During the previous work on PCB's in air, samples were rarely found where the fingerprint would resemble the fingerprint of a commercial "AROCHLOR" mixture unless the sample was collected close to a known source and the concentrations of PCB's were significantly higher than the concentrations usually encountered in ambient air.

The clean-up procedures of ambient air samples can be questioned as well. It has been estimated that in the concentration range of PCB's in ambient air, at least 10^5 organic compounds can be expected to be present in similar level in a sample of "clean" air (17). Only a fraction of these low level impurities were identified and it is a reasonable assumption that a significant number may not be removed by the clean-up procedure. Some may have retention times close to the retention times of the PCB's and some may be detected by the EC detector as well.

This is further complicated by the fact that we are not looking for a single or small number of species. There are 210 possible isomers and homologues of PCB's; 102 of which were identified in commercial "AROCHLORS" and likely to be encountered in environmental samples (18).

Up to now for lack of a better way, identification and quantification has been usually accomplished by comparison of total peak area or height of all matching peaks in the sample with the peaks of a standard commercial "AROCHLOR" mixture (10,11). For most ambient air samples, the source of contamination is usually unknown and any similarity is likely to be purely fortuitous.

15) Hutzinger, O., Safe, S., and Zitko, V., Ibid pg. 15
16) Hutzinger, O., et al., The Chemistry of PCB, CRC-Press, 1974 pg 113-148
17) Kaiser, R.E., J. Chromatogr. Sci. 12, 36 (1974)
18) Weidmark, G. The OECD Study of the Analysis of PCB Report from the Institute of Analytical Chemistry, Stockholm, Sweden 1968.

The problem of identification and accuracy in PCB analysis is not easily solvable. Because of the complexity of commercial mixtures, identification of individual isomers and homologues was not practical until recently . One possible solution to the problem is to convert all of the PCB components to one entity by perchlorination (19). The total PCB content is then measured as dekachlorobiphenyl. Analytical methodology for this technique, however, has not been established completely.

Until recently, high resolution gas chromatography on capillary columns, $(GC)^2$, was limited to research and development laboratories only. In the last few years, coated glass-capillary columns of reasonable quality became commercially available as well as instruments designed for work with capillary columns. The advent of commercially available fused silica capillary columns of good and reproducible quality together with micro-processor controlled gas-chromatographs made the use of $(GC)^2$ attractive. Almost at the same time, a number of individual PCB's were synthesized and became commercially available. This made the $(GC)^2$ even more attractive and it was slowly introduced into routine PCB analysis. The advantages of $(GC)^2$ are obvious,

a) High resolution power of capillary columns as compared to packed columns (100,000 to 150,000 effective plates as compared to 2,000 to 5,000 effective plates per column) may enable resolution of the majority of individual PCB's from each other and from impurities.

b) Because of the high resolution power of $(GC)^2$ and commercial availability of many individual PCB's as standards, the identification and quantification technique may be improved. PCB's may be identified and quantified with higher degree of confidence even when the fingerprint does not match a commercial "AROCHLOR" mixture at all.

19) Berg, O.W. et al., Bull, Environ. Cont. Toxicol. 7, 338 (1972)

However some questions were not completely resolved at the time the analyses of the 1979 survey were performed. These were:

a) not all the individual PCB's, as they are identified and present in commercial AROCHLOR mixtures, were commercially available.

b) not even the $(GC)^2$ is able to resolve all individual PCB's.

c) There still remains the possibility that some impurities, present in ambient air sample and not removed by the clean-up procedure, may be identified as PCB's because of the close retention times under the used conditions.

The ARB-TDA-Monitoring and Instrumentation Development Unit continues the work on a more reliable method for identification and quantification of PCB's and may present soon a more confident method. However at the time the analyses were performed (1st quarter of 1980), the methodology used represented the best practical "state of the art".

EXPERIMENTAL PART:

A) Sampling Procedure and Sample Processing:

The sampling procedure and sample processing is described elsewhere (20). Processed samples were received sealed in glass ampoules and transferred for analysis into glass vials sealed with "Viton" septums. After analysis, the leftover sample solutions were resealed in glass ampoules and stored for eventual future reference.

20) PCB's monitoring in ambient air - MOE Report-ARB TDA -08-80

B) Gas-Chromatographic Conditions:

Gas-chromatograph	- Hewlett and Packard 5840A with a capillary injection port and EC detector
column	- Hewlett and Packard, fused silica capillary column, 0.2 mm ID, 25m long, coated with SP-2100
carrier gas	- Helium, 25 psi, 23 cm/sec at 120°C
make-up gas	- Nitrogen, 25 ml/min
ECD Temp	- 250°C
Inj. Port Temp.	- 250°C
Injection	- Splitless, 2 ul, valve closed for 30 sec., with H&P Auto-sampler 7672A, alternate vials with clean solvent (iso-octane) as wash immediately after injection.
Temp. Programming	- 70°C, at 1 min rate 10°C/min, at 7 min rate 3°C/min up to 220°C and hold.

C) Calibration:

Calibration of the GC was performed with a mixture of 44 individual PCB's in the ESTD mode. All samples were spiked with p,p'-DDE which served as an internal reference standard to correct for any changes in the retention times and was also used as a reference peak for the calculation of relative retention times. The GC was automatically recalibrated after every five samples.

Figure 2 is an example of a calibration run with a standard mixture of individual PCB's. Peaks and amounts (in ng/ml) are identified in Table 16. Peaks with retention times (RT) 20.12 and 23.51 min. are with all probability impurities present in the commercially available PCB's and were not identified at this time.

The calibration and analysis performed with this standard mixture has the main drawback that not all the PCB's identified in commercial "AROCHLOR" mixtures are commercially available (see Figure 3 to 8). Because only peaks which are in the standard mixture are automatically detected, quantified and reported, the analysis may eventually underestimate the concentration of PCB's in ambient air.

To overcome, at least temporary, this disadvantage, the following procedure was adopted.

a) retention times, relative to pp'-DDE, of all the PCB's in the standard mixture and all the major peaks in commercial "AROCHLORS" were calculated and tabulated (Table 17).

b) Because the relative response factors of the higher chlorinated biphenyls are reasonably close (Table 18), the response factors of the major "AROCHLOR" peaks were calculated as the average of the response factors of the two neighbouring peaks of the standard mixture and tabulated.

c) Relative retention times for all major peaks, which were not automatically quantified by the gas-chromatograph, were manually calculated and compared with the relative retention times of the major peaks identified in commercial "AROCHLORS". If the relative retention time was within $\pm$0.002 units, the peak was considered identified as a PCB and the amount calculated from the average response factor.

d) All peaks were automatically detected and quantified as PCB's and where the measured retention time did not agree with the expected retention time to within $\pm$0.02 min, these peaks were rejected.

e) The sum of PCB's as reported by the gas-chromatograph and calculated as in c) and d) was reported as total PCB's (Σ PCB's) for the purpose of this report.

DISCUSSION:

The superiority of the fused silica capillary column coated with SP-2100 as compared to packed column used in (11) is visible in the chromatograph of the standard mixture (Figure 2) and from the typical chromatographs of commercial "AROCHLOR" mixtures (Figures 3 to 8). The retention times are highly reproducible and stable over long periods of time if the maximum temperature during conditioning does not exceed 240°C and 220°C during the regular use and temperature programming. The life-span of the column is between 800-900 samples or 600-700 hours of analytical time.

The superiority of the capillary column is even more pronounced when comparing the chromatographs (Figure 9 to 14) and analytical results for packed and capillary column (Table 19) which indicate that:

1) the clean-up procedure does not completely separate the PCB's from the impurities. The impurities may coelute on the packed column with the PCB's and significantly increase the results.
2) The identification of individual PCB's at very low concentration levels (1 ng/ml) is almost impossible on a packed column . Because of the low resolution, the peaks are broad and may merge with the noise of the baseline or sometime may be seen only as an indication of a shoulder on a close, large peak. Even on a good packed column the reproducibility of retention times is below the reproducibility of a capillary column and peaks might be misidentified.

3) The peaks on a capillary column, due to its high resolution power, are very narrow. At very low concentration levels (1 ng/ml) and long retention times, the peaks are still narrow and high enough to be easily resolved from the baseline noise. In an identical air sample, the capillary column resolves a significantly higher number of peaks than a packed column (compare Figures 9 to 14). This suggests fewer impurities coeluting with the PCB's.

4) The retention times on a capillary column are very reproducible (within $\pm$0.1%) even over long periods of time. The confidence in the identification of individual PCB's is higher than for packed columns.

Note:

Even high resolution chromatography on a single capillary column cannot guarantee that the peaks identified as PCB's are only PCB's and not a mixture of PCB's and impurities or impurities only, eluting with the same or very close to retention time. We estimated that the confidence level for this type of analysis was between 60-70% and that the method may still overestimate the concentration of PCB's in ambient air. Therefore we developed a new high resolution gas chromatographic method (to be published), where the sample is analysed simultaneously on two capillary columns, each coated with a liquid phase of different polarity. Only peaks which are identified on both columns as a given type of PCB are reported in the final analysis as PCB's. We estimate that the confidence limit of this type of analysis is between 80-90%. Some of the samples were reanalysed by this method and the results were included in Table 19. The data confirm that even single column high resolution gas-chromatography overestimates the concentration of PCB's in ambient air samples.

CONCLUSIONS:

The single column high resolution gas chromatography of PCB's in ambient air samples is more reliable and increases the detection limit of PCB's to lower values than analysis on packed column. The resolution of PCB's from interfering compounds, which may be present in the processed sample improves significantly as well as identification of individual PCB's. Presented analytical data indicate that analyses on packed column overestimate the concentration of PCBs in ambient air as compared to $(GC)^2$ with a single capillary column.

TABLE .1

PROVINCE-WIDE PCB SURVEY

ALPHANUMERIC SITE-SAMPLE CODING SYSTEM (1979 Summer Survey)

Location	Site Code*	Particulars
Thunder Bay	THU-S-U1-	Ont. Government Bldg., 435 James St., Thunder Bay
	THU-S-R1-	Williams Residence, Little Norway Rd., Thunder Bay
Sudbury	SUD-S-S1-	LaSalle School yard (MOE Stn), New Sudbury
	SUD-S-R1	Dowling Fire Hall, Roof of MTC Bldg., Dowling
London	LON-S-S1	Hijazi Residence, 255 Wychwood Park
Sarnia	SAR-S-I1-	Marketing Bldg, (Imperial Oil-Esso) Vidal & Clifford St.
	SAR-S-U1-	MOE Stn 14049 - 156 Victoria St., N.
Moore Town	MOO-S-R1-	McEwen Farm, R.R. #1, Corunna
Windsor	WIN-S-U-	MOE Stn 12016 - corner of College & South St.
Hamilton	HAM-S-I1-	MOE Stn 29008, North Park
	HAM-S-I2-	MOE Stn , Barton St.
	HAM-S-U1-	Police Stn at Inverness & Wellington
	HAM-S-U2-	Public School, Hughson & McCaulay St.
St. Catharines/ Smithsville	STC-S-R1-	Fletcher Residence, Spring Creek Rd, R.R. #3, Smithsville
Nanticoke	NAN-S-R1-	North Walpole School, off Hwy 6, between Hagersville & Jarvis
	NAN-S-R2-	Brown Residence (Cdn Wildlife Ser. Bldg) R.R.#3 Port Rowan
Toronto	TOR-S-U1-	880 Bay St.,
	TOR-S-S1-	Seymour Residence, 12 Holford Crescent, Agincourt
Oshawa	OSH-S-U1-	MOE Stn 45024, Oshawa
Burlington	BUR-S-U1	Robertson Residence, 3249 Palmer Drive
Mississauga	MIS-S-U1-	Walter Residence, 1538 Springwell
	MIS-S-U2-	St. Helen's School, Bodley Rd
	MIS-S-U3-	Oliveira Residence, 2005 Carrera Lane
	MIS-S-U4-	Hainer Residence, 473 Apple Lane
Kingston	KIN-S-U1-	Neilson/Klemme Residence, 34 Third Ave.

*The alpha numerics: -UX-, -SX-, -IX-, -RX- indicate urban, suburban, industrial and rural land use, respectively. The X corresponds to the site number in the particular land use category for the location.

TABLE 2

Cartridge Blank Summary

		Average
Total No. of Cartridge Blanks	90	34.2 ng/ml ± 122.2 ng/ml
Total No. of Acceptable	78	6.9 ng/ml ± 5.8 ng/ml

Concentration Results

Range	No. Results
0 - 1 ng/ml	11
1 - 2	6
2 - 3	11
3 - 4	4
4 - 5	5
5 - 6	5
6 - 7	5
7 - 8	5
8 - 9	4
9 - 10	0
10 - 11	3
11 - 12	2
12 - 13	3
13 - 14	3
14 - 15	3
15 - 16	0
16 - 17	0
17 - 18	3
18 - 19	1
19 - 20	4
20	12

* Results are expressed as concentration of PCB in final 1.0 ml concentrate

TABLE 3

SUMMARY OF GLASSWARE PROVING RESULTS

	Average
Total no. of glassware batch provings = 139	19.19 ng/ml*
Total no. of batches accepted for use = 111 (79.7%)	5.76 ng/ml*

Concentration results

Range	# Results
0 - 1 ng/ml*	24
1 - 2	12
2 - 3	12
3 - 4	7
4 - 5	9
5 - 6	7
6 - 7	3
7 - 8	2
8 - 9	4
9 - 10	2
10 - 11	3
11 - 12	3
12 - 13	0
13 - 14	1
14 - 15	1
15 - 16	4
16 - 17	4
17 - 18	2
18 - 19	3
19 - 20	1
20	2

* Results expressed as concentration of final 1.0 ml concentrate

TABLE 4

Supplied by MOE

Quality Control Cartridges

Sample No.	ng PCB Spiked	% Total Recovery	Isomer Max%	Isomer Min %
QC 43	77.9	34.9	62.6	0.0
QC 42	367.8	60.4	83.2	51.1
QC 41	294.2	86.0	131.0	61.0
QC 40	220.7	80.0	100.2	67.9
QC 39	147.1	91.0	184.1	70.5
QC 38	73.6	96.4	286.0	56.2
QC 37	4546.5	109.6	195.1	72.6
QC 36	363.6	76.7	103.0	30.9
QC 35	272.7	59.7	130.	272
QC 34	181.8	110.0	159.	16.1
QC 33	90.9	24.4	63.6	0.0
QC 32	389.7	181.9%	305.6	42.7
QC 31	311.7	90.1%	144.1	48.4
QC 30	233.8	71.5	103.0	15.0
QC 29	155.9	71.3	157	24.4
QC 28	77.9	75.5	290.2	0.0
QC 27	367.8	65.4	87.5	41.5
QC 26	294.2	76.1	102.	64.2
QC 25	220.7	80.4	120.	61.0
QC 24	147.1	82.7	119.5	72.9
QC 23	73.6	71.8	126.3	50.4
QC 22	454.5	66.3	85.2	53.2
QC 21	363.6	69.7	175.2	27.0

TABLE 4(continued)

QC 20	272.7	65.4	119.7	0.0
QC 19	181.	63.2	114.4	0.0
QC 18	90.9	31.4	580	0.0
QC 17	389.7	97.8	262.8	40.2
QC 16	311.7	61.6	149.9	37.3
QC 15	233.8	182.5	323.6	69.2
QC 14	155.9	100.3	119.3	64.7
QC 13	77.9	91.7	155.4	0.0
QC 12	53.1	56.2	78.4	0.0
QC 11	143.7	65.1	119.5	14.9
QC 10	57.4	105.3	144.2	60.0
QC 9	28.7	134.0	186.1	79.1
QC 8	340.8	79.9	129.8	31.0
QC 7	136.3	66.0	70.4	45.3
QC 6	68.2	81.3	182.0	21.3
QC 5	45.3	88.6	161.1	60.3
QC 4	143.7	125.3	177.3	88.1
QC 3	57.5	79.9	125.8	56.2
QC 2	340.8	104.2	127.2	70.1
QC 1	136.3	92.1	116.9	0.0

mean recovery = 83.8% $\pm$31%

TABLE 5

House Standard Recoveries for Quality Control

Date	Amount Spiked	% Recovery	Max%	Min %
March 10/80	154.6 ng	71.3	146.6	0.0
March 7/80	154.6	71.1	135.9	50.2
March 3/80	154.6	62.2	83.3	28.4
Feb. 29/80	154,6	109.7	276.0	71.0
Feb. 28/80	154.6	85.6	142.2	62.5
Feb 27/80	154.6	93.5	282.7	56.3
Feb 26/80	154.6	66.4	100.7	42.7
Feb 21/80	154.6	89.4	153.8	77.3
Feb 20/80	154.6	71.8	124.5	63.3
Feb 22/80	154.6	78.2	254.3	11.0
Feb 19/80	154.6	108.4	203.6	63.3
Feb 11/80	154.6	97.9	133.6	0.0
Feb 6/80	154.6	99.8	147.7	21.2
Feb 5/80	154.6	108.2	200.3	60.3
Jan 30/80	154.6	55.5	84.8	34.9
Jan 25/80	154.6	85.2	105.8	65.5
Jan 18/80	154.6	141.7	228.0	82.5
Jan 17/80	154.6	86.0	115.8	66.7
Jan 16/80	795.5	93.0	122.9	50.1
Jan 15/80	795.5	90.1	112.6	43.3
Jan 14/80	795.5	89.2	355.0	68.0
Jan 11/80	795.5	59.4	180.5	25.4
Jan 10/80	795.5	82.0	172.0	26.0
Jan 9/80	795.5	89.2	355.0	68.9
Jan 8/80	795.5	102.0	242.0	76.8
Jan 7/80	795.5	98.0	137.0	53.3

overall mean recovery = 88% $\pm$ 19%.

TABLE 6

Summary Results of Daily Blanks

		Average
Total No. of Blanks Processes	40	12.1 ng/ml ± 22.6
Total No. of Blanks Meeting Criterion of 1 ng/m^3	32(80%)	3.1 ng/ml ± 3.6

Concentration Results

Range	#Results
0 - 1 ng/ml	12
1 - 5 ng/ml	14
5 - 10 ng/ml	4
10 - 20 ng/ml	2
20 ng/ml	8

Results are expressed as concentration of PCB in final 1.0 ml concentrate; divide by 20 for final ng/m^3 result

TABLE 7
COMPOSITION OF PCB ISOMERS CALIBRATION
MIXTURE USED FOR PACKED COLUMN ANALYSIS

PEAK NUMBER	ISOMER	FINAL CONC. ng/ml
1	2	97.15
2	4	130.50
3	22'	47.53
4	24	13.35
5	23	13.63
6	35	45.15
7	22'5	27.27
8	44'	120.15
9	22'66'	44.00
10	23'5	17.15
11	22'56'	28.15
12	23'4	18.25
13	22'55'	28.95
14	22'44'	17.65
15	22'3'5'	16.45
16	23'55'	9.60
17	22'33'	15.85
18	23'4'5	18.60
19	22'4'55'	15.90
20	23'44'6	9.00
21	22'33'66'	17.75
22	22'345'	14.60
23	33'44'	19.00
24	22'44'55'	5.00
25	22'33'44'	4.88

TOTAL FINAL CONC. = 795.51 ng/ml

*Note - Peak No corresponds to elution order of PCB isomers under analytical conditions indicated in the text.

TABLE 8
SUMMARY OF CALIBRATION RESULTS
CHANNEL A

Channel A Results 45 Calibration Runs

Peak No.*	Av. RT (Min)	% SD	Av. Cal. Factor	% SD
1	4.26	6.21	1.53	58.0
2	5.96	6.83	8.00	78.6
3	6.50	6.30	1.85	51.1
4	7.83	6.53	0.151	51.4
5	9.07	6.35	0.141	45.7
6	9.98	6.46	0.378	46.8
7	11.54	5.98	0.221	46.7
8	12.79	6.46	1.598	81.2
9	13.77	5.64	0.303	47.2
10	15.15	5.63	0.113	45.6
11	16.28	6.09	0.165	46.5
12	17.48	5.66	0.126	51.6
13	19.19	5.28	0.162	36.2
14	20.10	5.25	0.0883	34.1
15	21.86	5.02	0.0871	40.7
16	23.26	5.02	0.0401	69.5
17	24.73	4.77	0.0805	53.6
18	27.60	4.75	0.0768	89.4
19	30.48	4.38	0.0735	87.7
20	32.28	4.24	0.0514	96.7
21	33.33	8.91	0.134	166.5
22	34.30	3.67	0.0537	70.3
23	37.24	3.04	0.0894	127.8
24	40.71	2.04	0.0759	327.1
25	45.41	2.25	0.0999	195.6

* The isomers corresponding to these peak numbers are given in Table 6.

TABLE 9
SUMMARY OF CALIBRATION RESULTS
CHANNEL B

Channel B Results — 42 Calibration Runs

Peak No.*	Av RT (Min)	% SD	Av. Cal.Factor	% SD
1	4.38	4.63	1.905	135.8
2	6.14	4.61	6.407	126.7
3	6.72	4.44	1.298	39.0
4	8.10	4.43	0.0987	60.6
5	9.37	4.28	0.0925	38.7
6	10.32	4.22	0.2485	45.7
7	11.95	4.06	0.1409	46.9
8	13.22	4.12	1.004	65.5
9	14.27	3.88	0.1942	46.9
10	15.70	3.79	0.07153	46.0
11	16.83	3.68	0.1053	53.6
12	18.05	3.63	0.0805	48.9
13	19.83	3.48	0.1119	51.7
14	20.76	3.44	0.0621	59.3
15	22.55	3.30	0.0625	49.2
16	23.99	3.22	0.0270	64.9
17	25.47	3.13	0.0552	55.2
18	28.64	5.91	0.0518	114.5
19	31.36	2.87	0.0389	48.6
20	33.18	2.65	0.0317	46.8
21	34.26	2.46	0.0865	79.4
22	35.23	2.51	0.0413	135.3
23	38.01	2.00	0.1172	192.6
24	41.33	1.40	0.0199	152.3
25	46.19	1.55	0.1077	347.2

* The isomers corresponding to these peak numbers are given in Table 6.

TABLE 10
SUMMARY OF CALIBRATION RESULTS
CHANNEL C

Channel C Results — 18 Calibration Runs

Peak No.*	Av. RT (Min)	% SD	Av. Cal.Factor	% SD
1	4.58	1.29	0.702	106.8
2	6.39	1.36	1.874	38.1
3	6.97	1.35	0.512	36.5
4	8.36	1.35	0.0407	28.0
5	9.67	1.38	0.0427	27.3
6	10.60	1.38	0.1067	32.3
7	12.27	1.35	0.0639	38.7
8	13.52	1.38	0.333	40.7
9	14.61	1.32	0.0892	40.5
10	16.03	1.29	0.0311	32.5
11	17.19	1.28	0.0485	34.8
12	18.42	1.23	0.0350	31.4
13	20.19	1.21	0.0497	31.8
14	21.12	1.19	0.0275	34.0
15	22.94	1.15	0.0285	33.2
16	24.35	1.14	0.0123	14.7
17	25.88	1.11	0.0254	29.6
18	28.76	1.08	0.0202	15.3
19	31.71	1.02	0.0181	18.8
20	33.55	0.98	0.0139	16.3
21	34.63	0.88	0.0559	28.8
22	35.49	0.80	0.0150	20.4
23	38.13	0.64	0.0292	38.0
24	41.43	0.41	0.00543	35.7
25	46.51	0.60	0.01104	16.7

* The isomers corresponding to these peak numbers are given in Table 6.

TABLE 11
SUMMARY OF PRECISION ASSAYS (% SD)
CHANNEL A

Peak No.*	Range (%)	
	Min	Max
1	3.8	138.8
2	4.6	39.6
3	4.3	20.9
4	2.1	23.4
5	1.4	21.8
6	1.4	19.5
7	1.7	14.9
8	1.6	19.4
9	0.9	15.8
10	1.0	12.1
11	0.9	11.3
12	1.1	12.0
13	1.0	9.5
14	1.3	9.9
15	1.0	12.7
16	2.3	9.3
17	2.2	10.3
18	1.7	8.1
19	1.7	6.7
20	1.6	10.2
21	1.8	19.8
22	1.4	28.4
23	1.5	51.9
24	6.6	37.0
25	8.3	46.6

Number of Determinations = 9

* For peak identification see Table 6.

TABLE 12
SUMMARY OF PRECISION ASSAYS (%SD)
CHANNEL B

Peak No.*	Range (%)	
	Min	Max
1	1.8	91.4
2	4.4	78.0
3	7.6	71.1
4	1.3	86.8
5	4.6	77.3
6	4.4	72.6
7	5.9	72.7
8	8.3	71.5
9	4.3	82.0
10	2.7	73.5
11	3.0	74.6
12	6.1	70.5
13	2.9	65.1
14	2.9	71.4
15	4.5	71.3
16	4.4	90.2
17	4.5	80.3
18	4.7	155.0
19	4.1	132.2
20	2.4	133.8
21	2.6	151.9
22	3.5	163.9
23	8.1	166.6
24	8.3	170.6
25	3.4	176.4

Number of Determinations = 10

* For peak identification see Table 6.

TABLE 13
SUMMARY OF PRECISION ASSAYS (% SD)
CHANNEL C

Peak No.*	Range (%)	
	Min	Max
1	13.9	55.3
2	4.4	33.0
3	15.8	31.2
4	14.5	15.7
5	11.6	38.3
6	12.1	27.2
7	10.4	34.0
8	9.6	32.2
9	11.3	34.8
10	10.5	29.0
11	10.9	31.0
12	8.7	30.9
13	4.0	29.2
14	3.7	31.3
15	8.2	30.2
16	5.1	9.9
17	7.7	26.5
18	6.6	12.6
19	5.0	10.9
20	5.9	14.6
21	10.7	25.2
22	10.9	51.1
23	12.3	35.5
24	13.4	21.9
25	6.8	9.3

Number of Determinations = 3

* For peak identification see Table 6.

TABLE 14
SUMMARY OF LINEARITY RESULTS

Channel A		Varian 3700	8 Determinations
Peak No.*	Av. Intercept	Av. Slope	Cal.Factor
1	1.164 ± 142 %	$1.640 \times 10^{-4} \pm 33.1$ %	1.53
2	4.976 ± 142	$1.255 \times 10^{-4} \pm 38.1$	8.00
3	1.824 ± 128	$1.578 \times 10^{-4} \pm 28.4$	1.85
4	0.220 ± 348	$1.458 \times 10^{-5} \pm 27.3$	0.151
5	-0.0768 ± 323	$1.491 \times 10^{-5} \pm 28.6$	0.141
6	0.0184 ± 4190	$4.011 \times 10^{-5} \pm 28.9$	0.378
7	-0.0156 ± 3052	$2.261 \times 10^{-5} \pm 25.6$	0.221
/8	3.305 ± 185	$1.450 \times 10^{-4} \pm 43.1$	1.598
9	-0.0536 ± 1789	$3.151 \times 10^{-5} \pm 25.5$	0.303
10	0.0200 ± 2068	$1.123 \times 10^{-5} \pm 29.5$	0.113
11	-0.0567 ± 1314	$1.721 \times 10^{-5} \pm 27.3$	0.165
12	0.3484 ± 106	$1.153 \times 10^{-5} \pm 32.9$	0.126
13	0.1168 ± 600	$1.705 \times 10^{-6} \pm 32.7$	0.162
14	0.1574 ± 240	$8.837 \times 10^{-6} \pm 32.4$	0.0883
15	0.1853 ± 141	$8.866 \times 10^{-6} \pm 32.2$	0.0871
16	0.1106 ± 228	$3.616 \times 10^{-6} \pm 40.0$	0.0401
17	0.2651 ± 140	$7.140 \times 10^{-6} \pm 37.7$	0.0805
18	0.2015 ± 301	$6.289 \times 10^{-6} \pm 36.6$	0.0768
19	0.7976 ± 220	$5.156 \times 10^{-6} \pm 30.5$	0.0735
20	0.2800 ± 156	$3.895 \times 10^{-6} \pm 29.9$	0.0514
21	0.5310 ± 110	$9.856 \times 10^{-6} \pm 28.0$	0.134
22	0.3259 ± 157	$4.281 \times 10^{-6} \pm 26.9$	0.0537
23	0.5382 ± 130	$5.434 \times 10^{-6} \pm 34.6$	0.0894
24	0.3378 ± 119	$2.017 \times 10^{-6} \pm 29.0$	0.0759
25	0.1579 ± 141	$2.601 \times 10^{-6} \pm 38.3$	0.0999

16.08 - Minimum Detectable Concentration (total)

* For peak identification see Table 6.

TABLE 15
SUMMARY OF LINEARITY RESULTS

Channel B		Varian 3700	10 Determinations
Peak No.*	Av. Intercept	Av. Slope	Cal. Factor
1	4.229 ± 273 %	1.156×10^{-4} ± 38.9 %	1.905
2	6.197 ± 200	3.883×10^{-4} ± 50.3	6.407
3	1.161 ± 113	1.118×10^{-4} ± 36.0	1.298
4	0.085 ± 360	9.892×10^{-6} ± 39.2	0.0987
5	0.0681 ± 339	1.016×10^{-5} ± 36.6	0.0925
6	0.271 ± 561	2.723×10^{-5} ± 49.1	0.2485
7	0.0897 ± 963	1.476×10^{-5} ± 40.3	0.1409
8	2.664 ± 209	8.812×10^{-5} ± 42.7	1.004
9	0.301 ± 397	2.069×10^{-5} ± 41.4	0.1942
10	0.184 ± 462	7.449×10^{-6} ± 39.0	0.07153
11	-0.0518 ± 1431	1.117×10^{-5} ± 43.0	0.1053
12	0.0794 ± 708	8.155×10^{-6} ± 39.3	0.0805
13	-0.0228 ± 3443	1.192×10^{-5} ± 44.0	0.1119
14	0.0354 ± 1525	6.289×10^{-6} ± 42.4	0.0621
15	0.0163 ± 3300	6.527×10^{-6} ± 40.8	0.0625
16	0.0670 ± 353	2.683×10^{-6} ± 46.1	0.0270
17	0.1040 ± 507	5.504×10^{-6} ± 37.2	0.0552
18	0.5705 ± 109	4.334×10^{-6} ± 45.7	0.0518
19	0.2888 ± 188	3.796×10^{-6} ± 50.3	0.0389
20	0.2080 ± 175	2.870×10^{-6} ± 41.87	0.0317
21	0.5233 ± 150	7.080×10^{-6} ± 47.2	0.0865
22	0.4275 ± 150	2.955×10^{-6} ± 47.9	0.0413
23	1.527 ± 107	4.025×10^{-6} ± 45.8	0.1172
24	0.2055 ± 193	1.050×10^{-6} ± 47.8	0.0199
25	0.3936 ± 142	2.302×10^{-6} ± 49.2	0.1077

19.26 - Minimum Detectable Concentration (total)

* For peak identification see Table 6.

TABLE 16
SUMMARY OF LINEARITY RESULTS

Channel C		Varian 3700	4 Determinations
Peak No.*	Av. Intercept	Av. Slope	Cal.Factor
1	4.302 ± 138 %	$7.074 \times 10^{-5} \pm 43.8$	0.702 %
2	7.055 ± 112	$2.583 \times 10^{-4} \pm 60.5$	1.874
3	1.775 ± 89.5	$6.482 \times 10^{-5} \pm 49.6$	0.512
4	0.09677 ± 195	$4.806 \times 10^{-6} \pm 34.1$	0.0407
5	0.0990 ± 2035	$4.833 \times 10^{-6} \pm 31.6$	0.0427
6	0.0256 ± 293	$1.215 \times 10^{-5} \pm 37.5$	0.1067
7	0.2064 ± 239	$7.048 \times 10^{-6} \pm 42.7$	0.0639
8	-0.8952 ± 172	$3.795 \times 10^{-5} \pm 42.1$	0.333
9	-0.3492 ± 188	$7.232 \times 10^{-6} \pm 80.7$	0.0892
10	-0.1776 ± 79.9	$3.512 \times 10^{-6} \pm 37.2$	0.0311
11	-0.0657 ± 659	$5.520 \times 10^{-6} \pm 42.7$	0.0485
12	-0.1579 ± 131	$3.795 \times 10^{-6} \pm 36.2$	0.0350
13	-0.0638 ± 441	$5.595 \times 10^{-6} \pm 38.8$	0.0497
14	-0.1439 ± 247	$2.231 \times 10^{-6} \pm 75.5$	0.0275
15	0.1098 ± 197	$3.119 \times 10^{-6} \pm 39.2$	0.0285
16	-0.0367 ± 325	$1.298 \times 10^{-6} \pm 12.0$	0.0123
17	0.1092 ± 179	$2.731 \times 10^{-6} \pm 36.4$	0.0254
18	0.2057 ± 193	$2.121 \times 10^{-6} \pm 17.6$	0.0202
19	-0.0327 ± 1610	$1.946 \times 10^{-6} \pm 14.1$	0.0181
20	0.2889 ± 113	$1.343 \times 10^{-6} \pm 216$	0.0139
21	0.7619 ± 110	$3.427 \times 10^{-6} \pm 39.1$	0.0359
22	0.4185 ± 110	$1.498 \times 10^{-6} \pm 27.4$	0.0150
23	0.8503 ± 128	$2.034 \times 10^{-6} \pm 25.3$	0.0292
24	-0.2139 ± 38	$7.179 \times 10^{-7} \pm 16.7$	0.00543
25	-0.0157 ± 1950	$1.1312 \times 10^{-6} \pm 32.4$	0.01104

18.46 - Minimum Detectable Concentration (total)

* For peak identification see Table 6.

TABLE 17

Identification of individual polychlorinated biphenyls in the standard mixture.

RT	EXP RT	AREA	CAL #	AMT	
12.34	12.34	3330	2	10.615	2-
14.15	14.16	6452	3	93.733	3-
14.33	14.33	5254	4	22.688	4--
15.38	15.39	3574	5	3.871	22'-
16.85	16.85	16210	6	5.554	24-
17.72	17.72	15588	7	5.695	23-
18.64	18.63	18458	8	5.478	35-
19.49	19.48	23798	9	4.159	246-
19.69	19.68	7914	10	9.583	33'-
19.99	19.99	18378	11	5.132	34-
20.20	20.20	19888	12	5.616	22'5-
21.94	21.94	11258	13	3.652	44'-
22.47	22.46	19318	14	3.563	22'66'-
22.98	22.98	21488	15	4.884	23'5-
23.51	23.51	15128	16	3.758	24'5-
25.14	25.14	16588	17	3.928	23'4'-
25.38	25.38	23588	18	3.972	22'55'-
25.53	25.53	23998	19	3.587	22'4'5-
25.76	25.76	25228	20	4.844	22'44'-
26.05	26.06	24248	21	3.443	2356-
26.25	26.25	24968	22	3.788	22'466'-
27.81	27.81	28668	23	3.874	22'3'5-
27.35	27.35	18188	24	3.359	23'55'-
27.71	27.71	17538	25	3.187	22'33'-
28.81	28.82	26648	26	3.679	22'45'6-
28.48	28.48	24368	27	3.482	22'44'6-
28.78	28.69	21988	28	3.156	2345-
29.37	29.37	33858	29	3.758	23'45'6-
30.88	30.88	25988	30	4.885	22'44'66'-
30.48	30.48	21158	31	3.271	22'455'-
31.14	31.14	32668	32	3.719	23'44'6-
31.87	31.88	24268	33	2.979	22'345'-
32.23	32.25	27288	(R) 1	3.544	pp'-DDE
32.39	32.37	12878	34	3.387	33'44'-
32.82	32.82	26038	35	3.598	22'44'5'6-
33.38	33.38	24988	36	3.576	22'355'6-
34.19	34.18	27388	37	3.633	22'344'6-
34.54	34.54	34928	38	3.769	22'3456'-
35.63	35.62	20838	39	4.818	22'44'55'-
36.27	36.26	39638	40	3.632	22'3455'-
36.58	36.58	27888	41	3.588	22'344'5-
37.45	37.45	29628	42	3.595	22'33'45-
38.53	38.53	19338	43	3.727	22'33'44'-
39.34	39.35	24618	44	3.275	22'3455'6-
48.49	48.49	14868	45	3.178	233'44'5-

AMT = ng PCB/ml.

RT = retention time as detected

EXP RT = expected retention time

AREA = peak area in arbitrary units

TABLE 18.

Relative Retention Time of PCB's in the Standard Mixture and Major Peaks in Commercial "AROCHLORS"

(pp-DDE=1.00)

Std. Peak#	RRT	PCB
2	0.352	2-
3	0.412	3-
4	0.417	4-
5	0.452	2,2'-
6	0.500	2,4-
	0.518	1016,1221,1232,1242
7	0.528	2,3-
8	0.558	3,5-
	0.563	1016,1232,1242,1248
9	0.586	2,4,6-
10	0.592	3,3'-
11	0.602	3,4-
12	0.609	2,2',5-
	0.639	1221,1232,1260
	0.643	1016,1221,1232,1242,1248
13	0.666	2,2',6,6'-
14	0.683	2,3',5-
15	0.697	2,4',5-
16	0.717	2,3',4'-
	0.729	1016,1221,1232,1242,1248
	0.739	1016,1221,1232,1242,1248,1254,1260
	0.754	1016,1232,1242,1248
17	0.770	2,2',5,5'-
18	0.778	2,2',4',5-
19	0.783	2,2'4,4'-
20	0.790	2,3,5,6-
	0.796	1016,1221,1232,1242,1248,1254,1260
21	0.800	2,2',4,6,6'-
22	0.806	2,2',3',5-
	0.811	1016,1232,1242,1248
23	0.831	2,3',5,5'-
24	0.842	2,2'3,3'-
25	0.853	2,2',4,5',6-
26	0.863	2,2'4,4',6-
	0.869	1242,1248
27	0.878	2,3,4,5-
28	0.885	2,3',4',5-
	0.890	1016,1232,1242,1248
	0.893	1016,1254,1260
29	0.907	2,3',4,5',6-
	0.911	1242.1249.1254
30	0.928	2,2',4,4',6,6'-
	0.936	1242,1248,1254,1260
31	0.944	2,2',4,5,5'-
	0.951	1232,1242,1248,1254
32	0.965	2,3',4,4',6-
	0.970	1248,1254
	0.980	1232,1242,1248,1254
33	0.989	2,2',3,4,5'-
	0.995	1232,1242,1248,1254
34	1.005	3,3',4,4'
35	1.019	2,2',4,4',5',6
	1.024	1242,1248,1254
36	1.038	2,2',3,5,5',6-
	1.051	1248,1254,1260
	1.061	1254
37	1.064	2,2',3,4,4'6-
38	1.075	2,2',3,4,5,6'-
	1.083	1254
	1.098	1254,1260
39	1.110	2,2',4,4',5,5'-
40	1.131	2,2',3,4,5,5'-
41	1.141	2,2',3,4,4',5-
	1.145	1254,1260
	1.156	1248,1254
	1.162	1221,1254,1260
42	1.171	2,2',3,3',4,5-
	1.199	1254,1260
43	1.207	2,2',3,3',4,4'-
	1.222	1254,1260
44	1.234	2,2',3,4,5,5',6-
	1.247	1254,1260
	1.257	1254,1260
	1.269	1254,1260
45	1.273	2,3,3',4,4',5-

TABLE 19

RELATIVE RESPONSE FACTORS OF SOME PCB'S

(3-Mono = 1.00)

MONO'S	REL. RESPONSE
2-	21
3-	1
4-	11
	AVG.=11

DI'S	REL. RESPONSE
2,2'-	48
2,5-	206
2,3-	224
3,5-	150
3,3'-	82
3,4-	166
	AVG.=146

TRI'S	REL. RESPONSE
2,4,6-	289
2,2',5-	211
2,4,5-	326
2,3',5-	319
2,4',5-	308
	AVG.=290

TETRA'S	REL. RESPONSE
2,2',6,6'-	224
2,2',4,6-	352
2,2',,6'-	248
2,3',4,6-	320
2,2',5,5'-	320
2,2',4',5-	335
2,4,4',6-	527
2,3,5,6-	361
2,2',3',5-	388
2,3',5,5'-	351
2,2',3,3'-	371
2,3,4,5-	296
2,3',4',5-	358
3,3',4,4'-	287
	AVG.=338

PENTA'S	REL. RESPONSE
2,2',4,6,6'-	313
2,2',4,5',6-	340
2,2',4,4',6-	355
2,2',3,4,6-	351
2,2',3,5,6-	364
2,3',4,5',6-	381
2,2',4,5,5'-	395
2,3',4,4',6-	369
2,2',3,4',5-	427
	AVG.=366

HEXA'S	REL. RESPONSE
2,2',4,4',6,6'-	367
2,2',4,4',5',6-	351
2,2',3,5,5',6-	378
2,2',3,4,4',6-	341
2,2',3,4,5,6'-	399
2,2',4,4',5,5'-	401
2,2',3,4,5,5'-	400
2,2',3,4,4',5-	440
2,2',3,3',4,5-	370
2,2',3,3',4,4'-	344
2,3,3',4,4',5-	291
	AVG.=371

HEPTA'S	REL. RESPONSE
2,2',3,4,5,5',6-	402

OCTA'S	REL. RESPONSE
2,2',3,3,5,5',6,6'-	378
2,2',3,3',4,5',6,6'-	290
2,2',3,4,4',5,6,6'-	366
	AVG.-345

TABLE 20

Comparison of Results Between Gas Chromatography with Packed Column, $(GC)^2$ and $(GC)^2$ with Dual Columns of Different Polarity

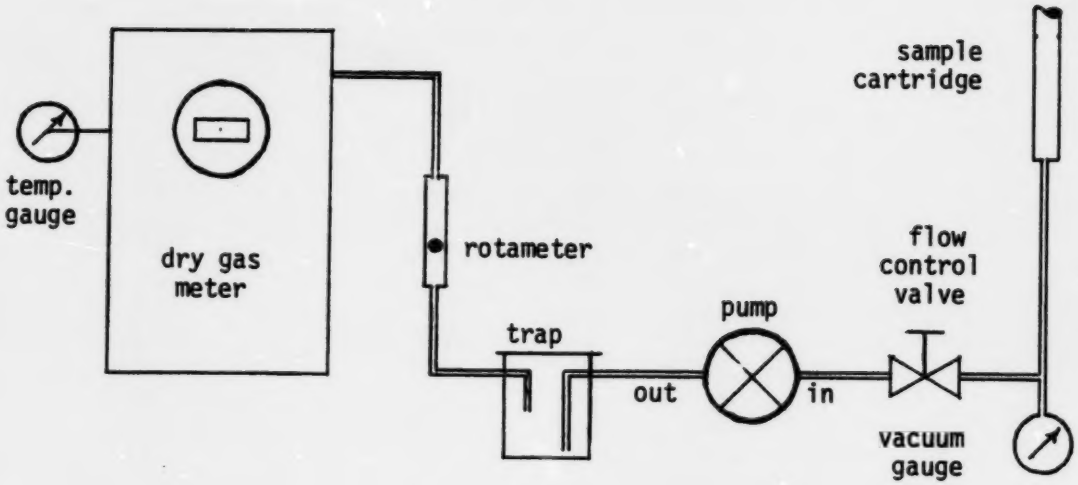
			Single Capillary Column			Dual Column
#	Sample Code	Packed Column	SP-2100	OV-1	SE-54	OV-1/SE-54
1	HAM-S1-I2-16	66	4.2	5.3	1.4	0.4
2	HAM-SI-I2-17	44	1.0	2.7	3.0	0.7
3	HAM-S1-I2-18	7.1	2.2	2.6	1.2	0.0
4	SAR-SI-UI-16	58	4.6*	6.1	4.3	0.6
5	SAR-S1-UI-18	6.2	1.6*	3.2	1.0	0.02
6	SUD-SI-SI-18	52	3.8*	2.3	2.1	0.0
7	SUD-SI-SI-17	53	1.7*	2.9	2.0	0.0
8	SUD-SI-SI-4	47	4.1*	3.9	2.8	0.3
9	SUD-SI-SI-1	66	3.9*	3.9	3.1	0.8
10	SAR-SI-UI-15	115	3.5	3.7	14	0.6
11	SAR-SI-UI-17	19	3.7*	3.3	2.3	0.2
12	HAM-SI-II-4	173	4.8*	5.2	4.1	1.4
13	HAM-SI-II-1	317	11*	11	7.0	3.3
14	TOR-SI-UI-1	28	12*	10	10	5.4
15	TOR-SI-UI-2	238	23*	16	15	6.9
16	TOR-SI-UI-18	6.4	4.1*	5.5	4.7	1.6
17	HAM-S1-U2-16	31	3.6*	2.3	1.7	0.2
18	MIS-S1-U4-15	6.7	2.4*	3.4	3.3	0.2
19	MIS-SI-U4-19	13	1.9*	2.2	2.4	0.2
20	MIS-SI-U4-17	1.5	4.0	2.4	1.8	0.4
21	HAM-S1-U2-4	128	2.4*	3.8	3.0	0.9
22	MIS-SI-U4-16	19	1.8*	2.5	2.0	0.1
23	HAM-SI-U2-18	25	4.4	2.2	1.6	0.2
24	HAM-SI-II-5	52	8.7*	0.7	1.6	0.2
25	LON-SI-SI-18	35	11	9.4	9.1	6.3
26	SAR-SI-II-2	1615	6.8*	4.3	6.5	2.1
27	HAM-SI-II-15	68	20*	5.9	9.7	1.9
28	MIS-S1-U1-3	-	11*	2.9	3.1	0.6

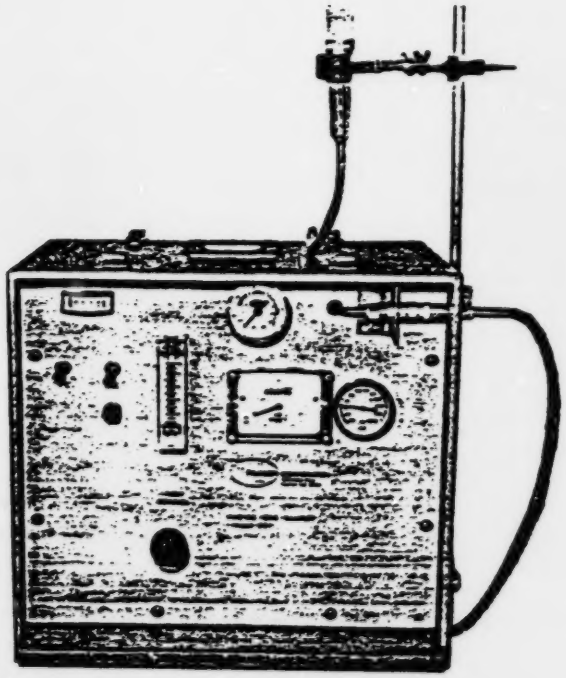
*A not well resolved peak is present around RT=26 min, which was originally considered as PCB. In this set of data the peak was excluded.

Concentrations are expressed as ng PCB's/m^3 air.

FIGURE 1

NUTECH 221 AC/DC GAS SAMPLER





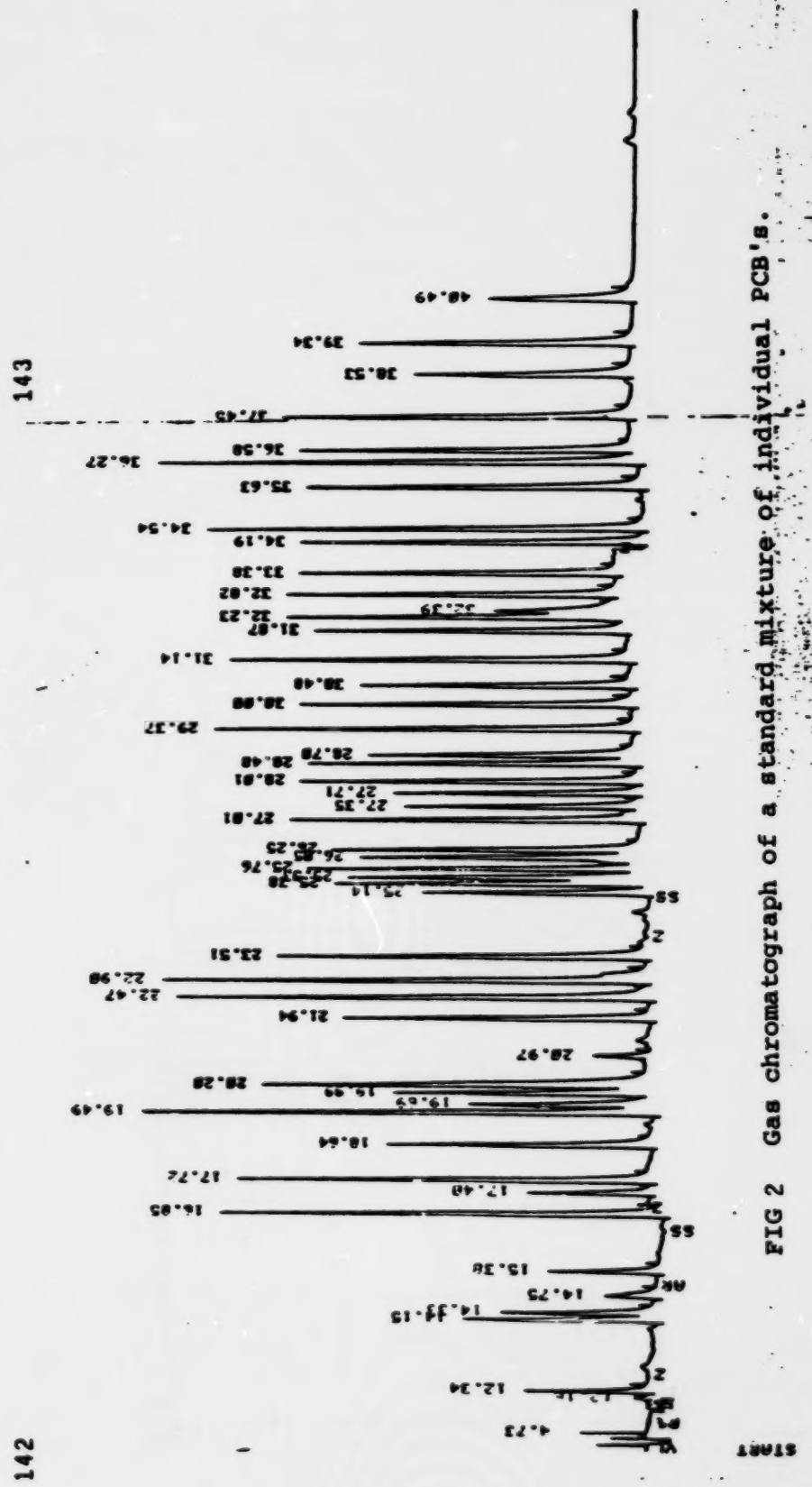


FIG 2 Gas chromatograph of a standard mixture of individual PCB's.

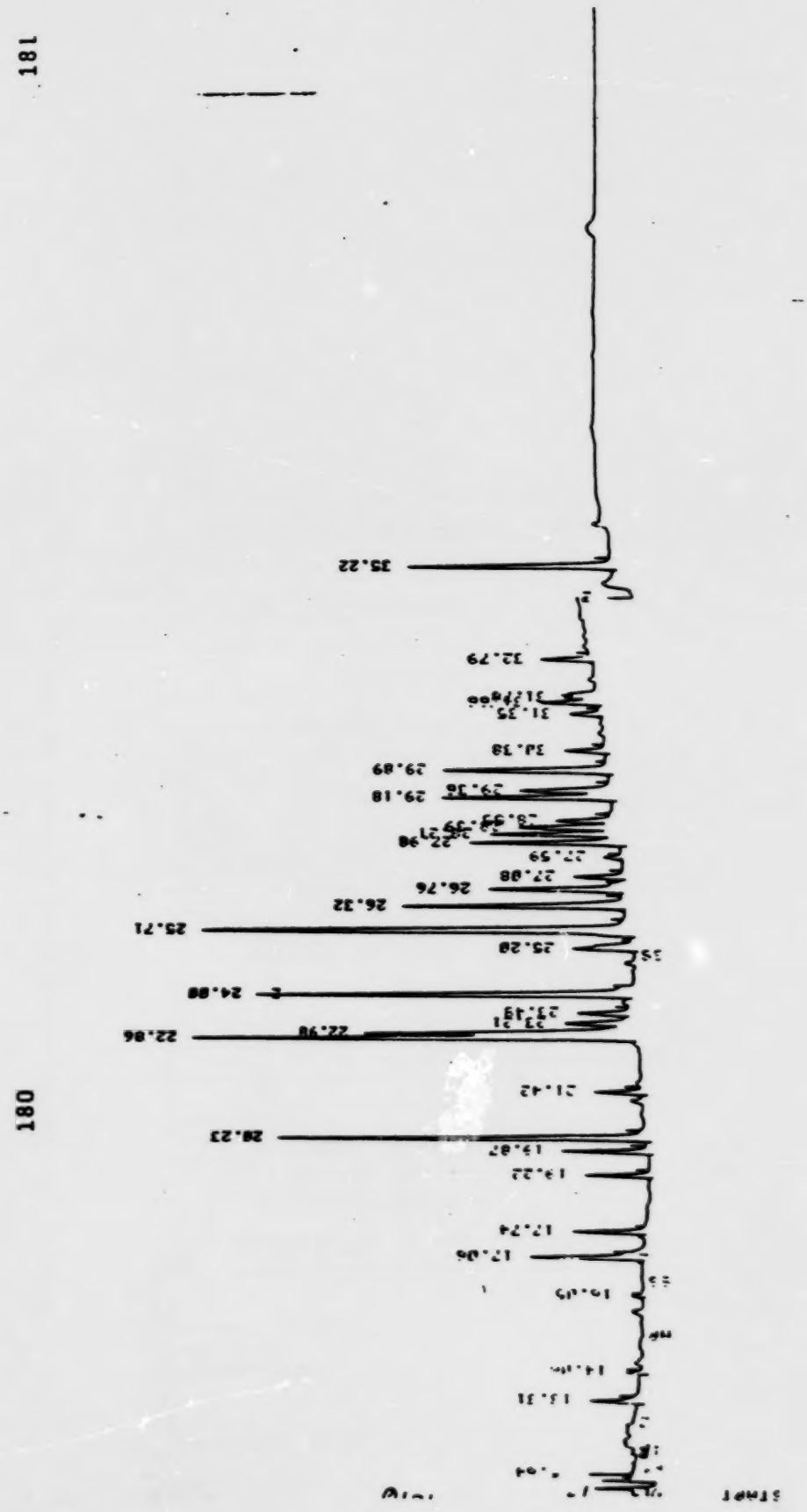


FIG.3. AROCHLOR 1016

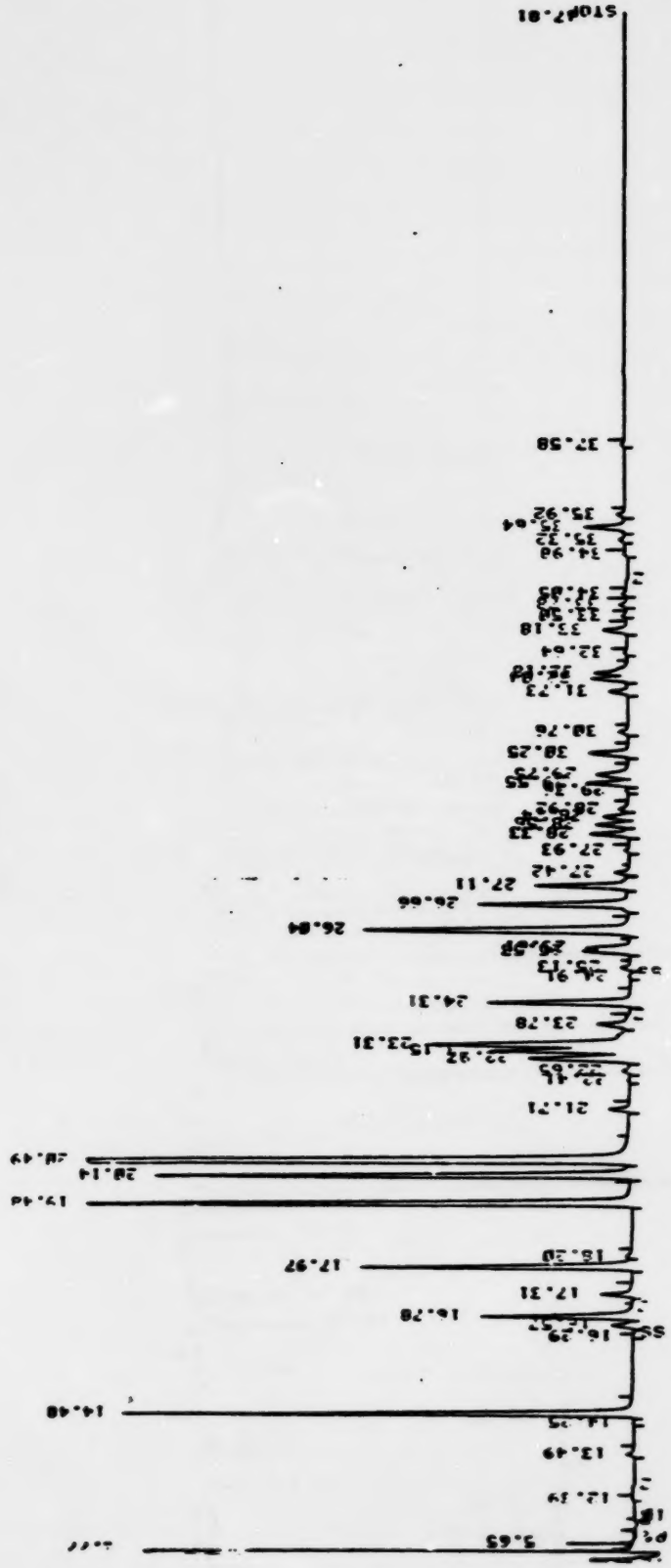


FIG 4. AROCHLOR 1221

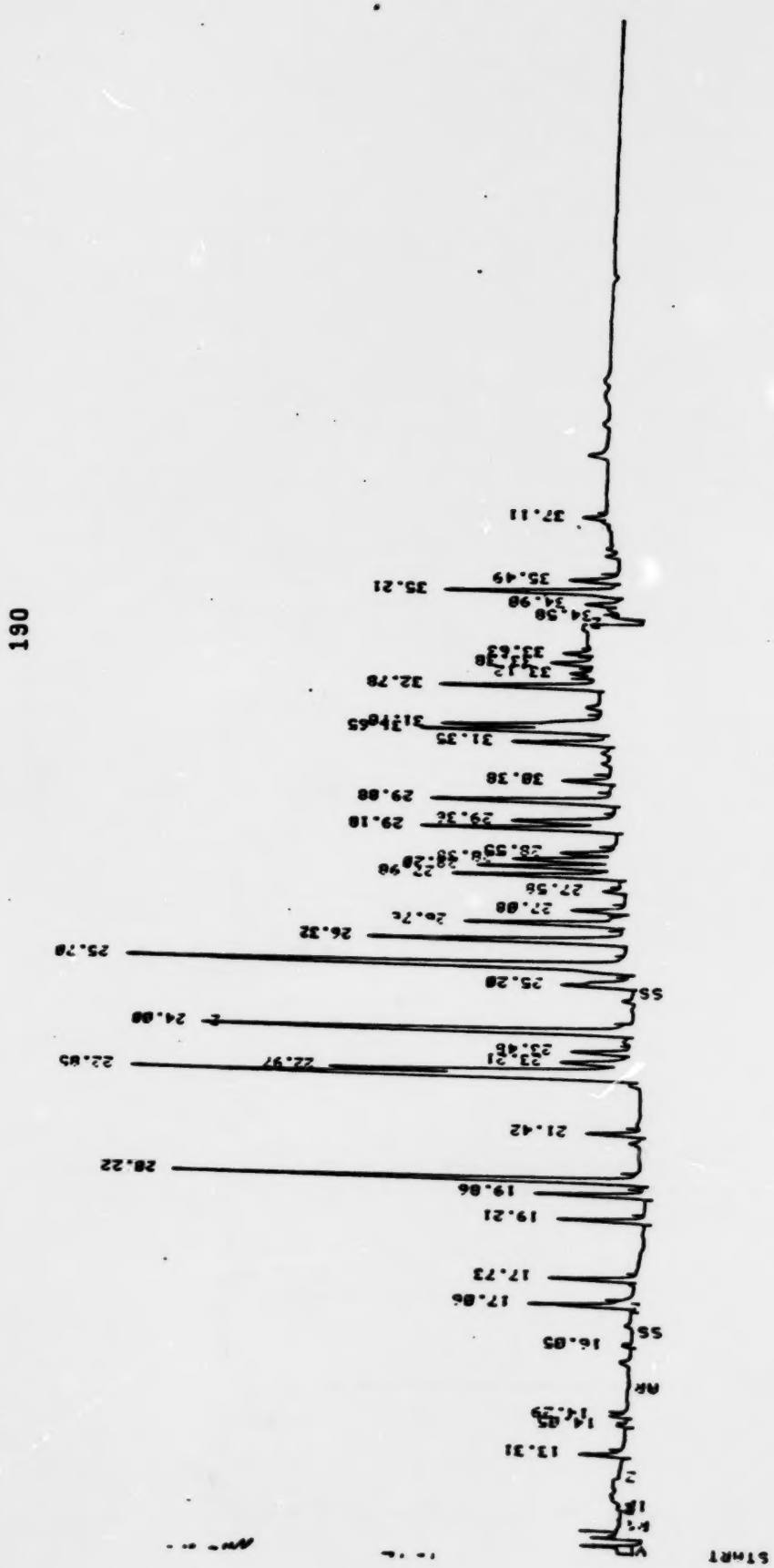


FIG.5. AROCHLOR 1242

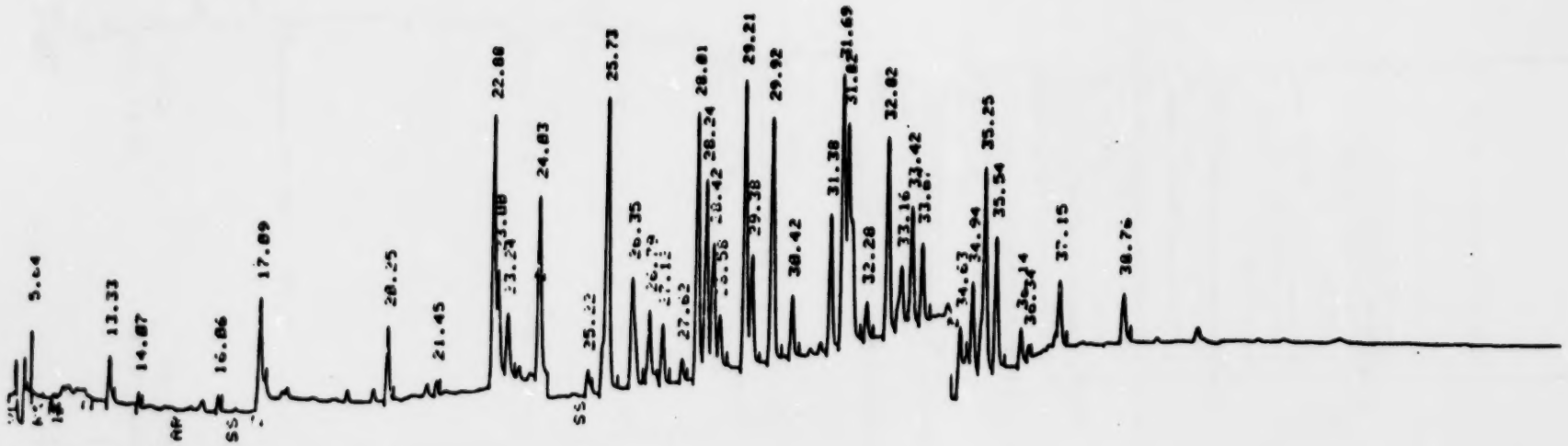


FIG.6. AROCHLOR 1248

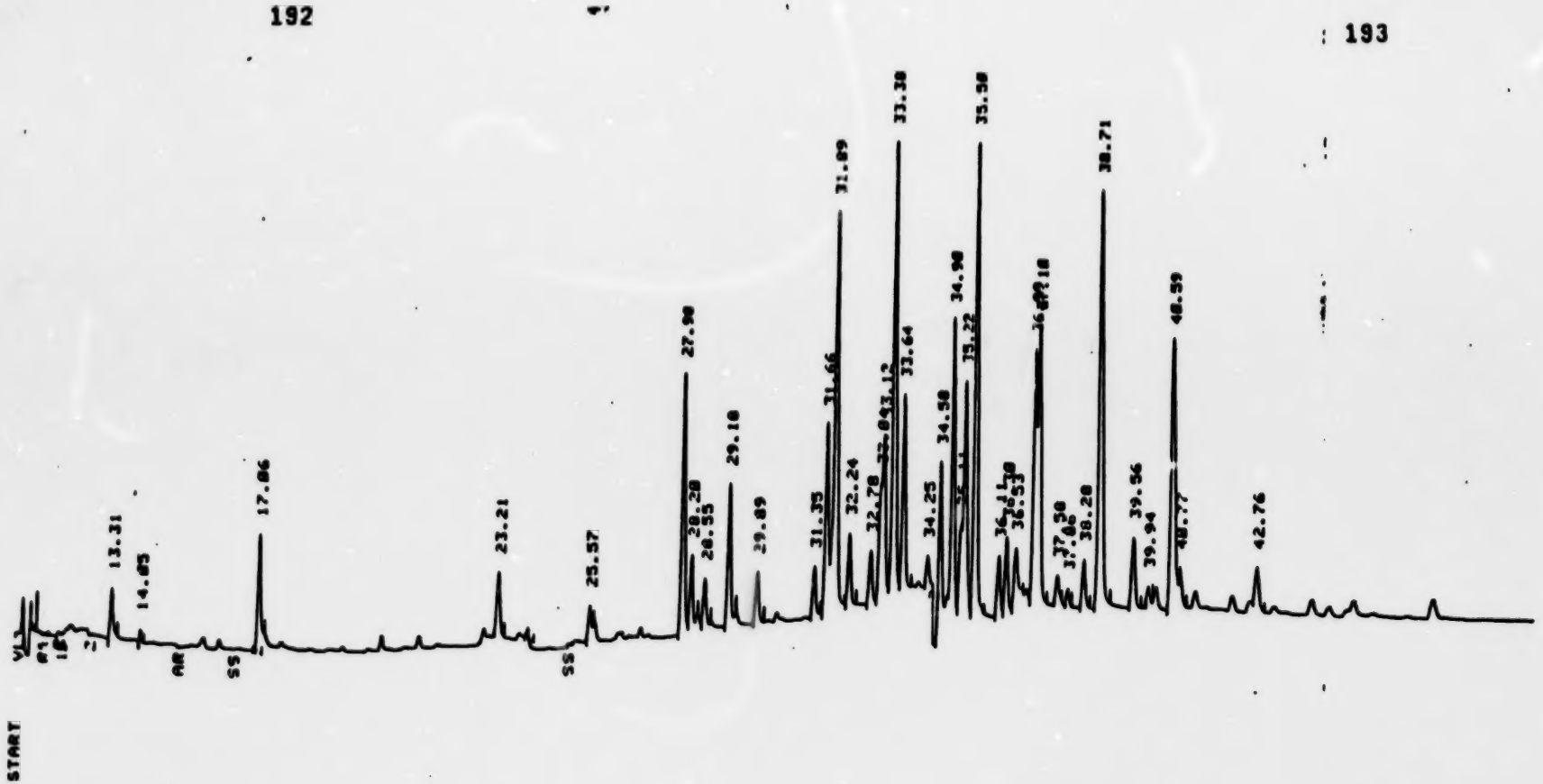


FIG.7 AROCHLOR 1254

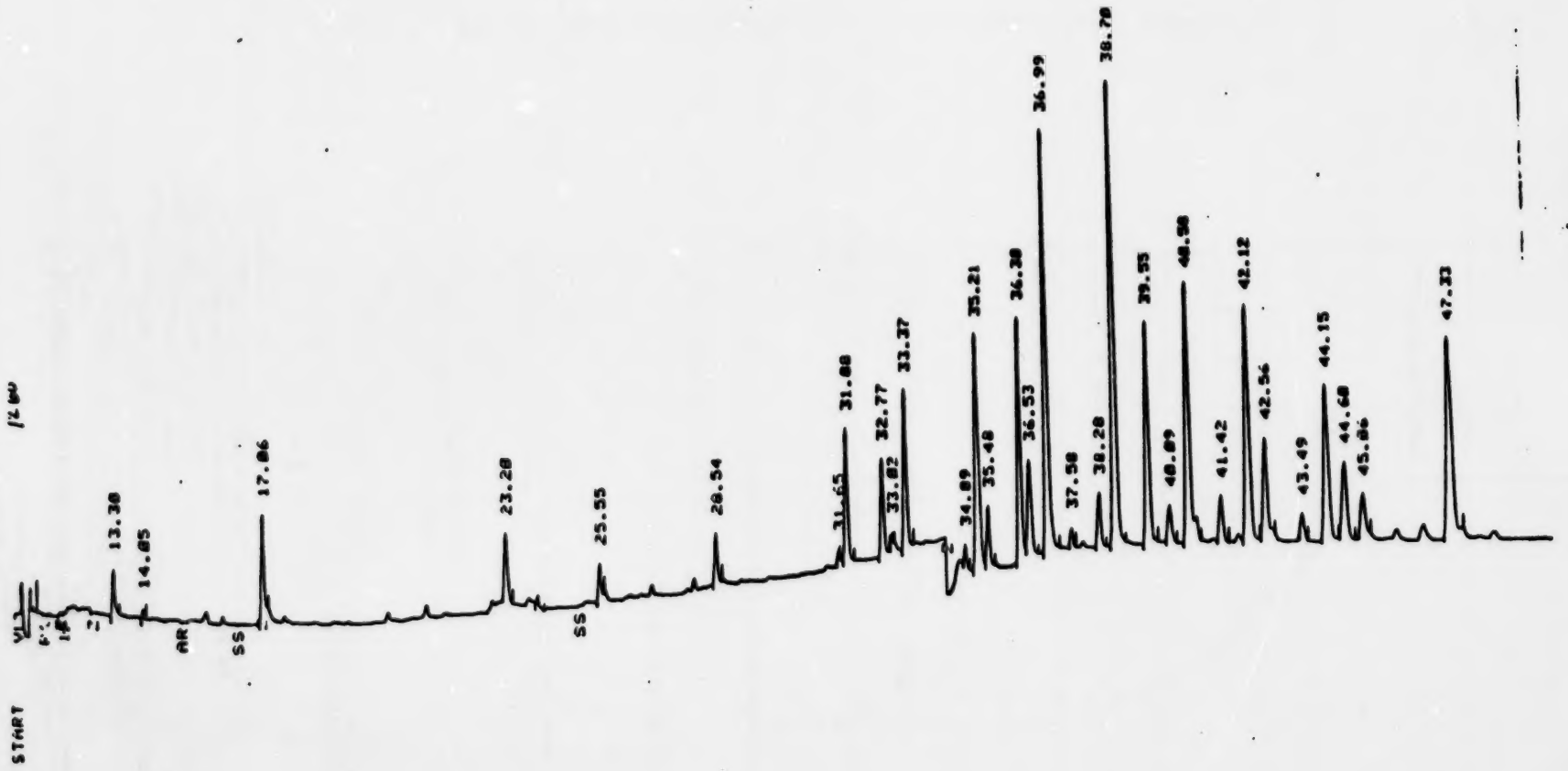


FIG. 8. AROCHLOR 1260

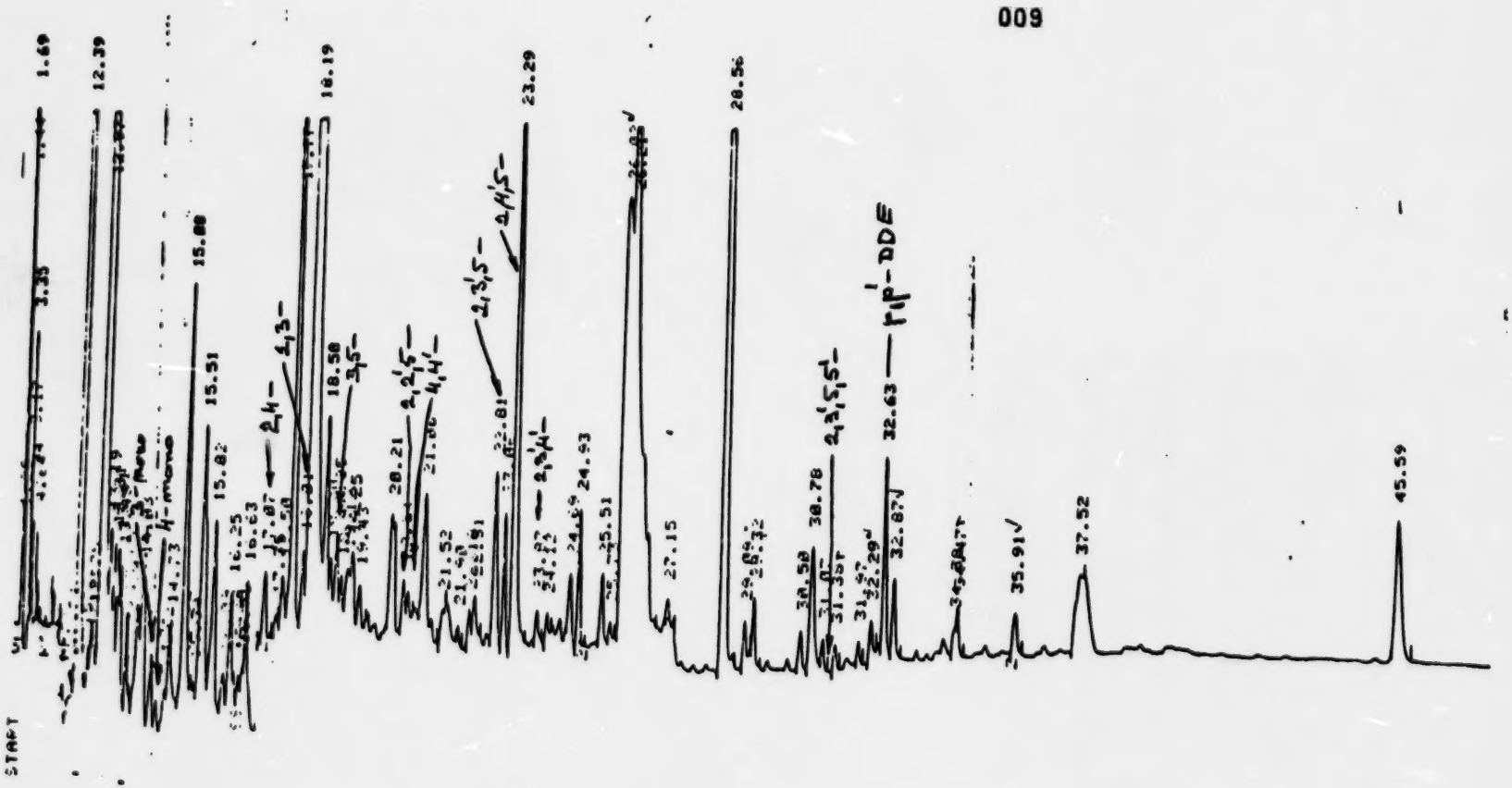


FIG.9. Air sample SAR-S-I_1-2 on capillary column.

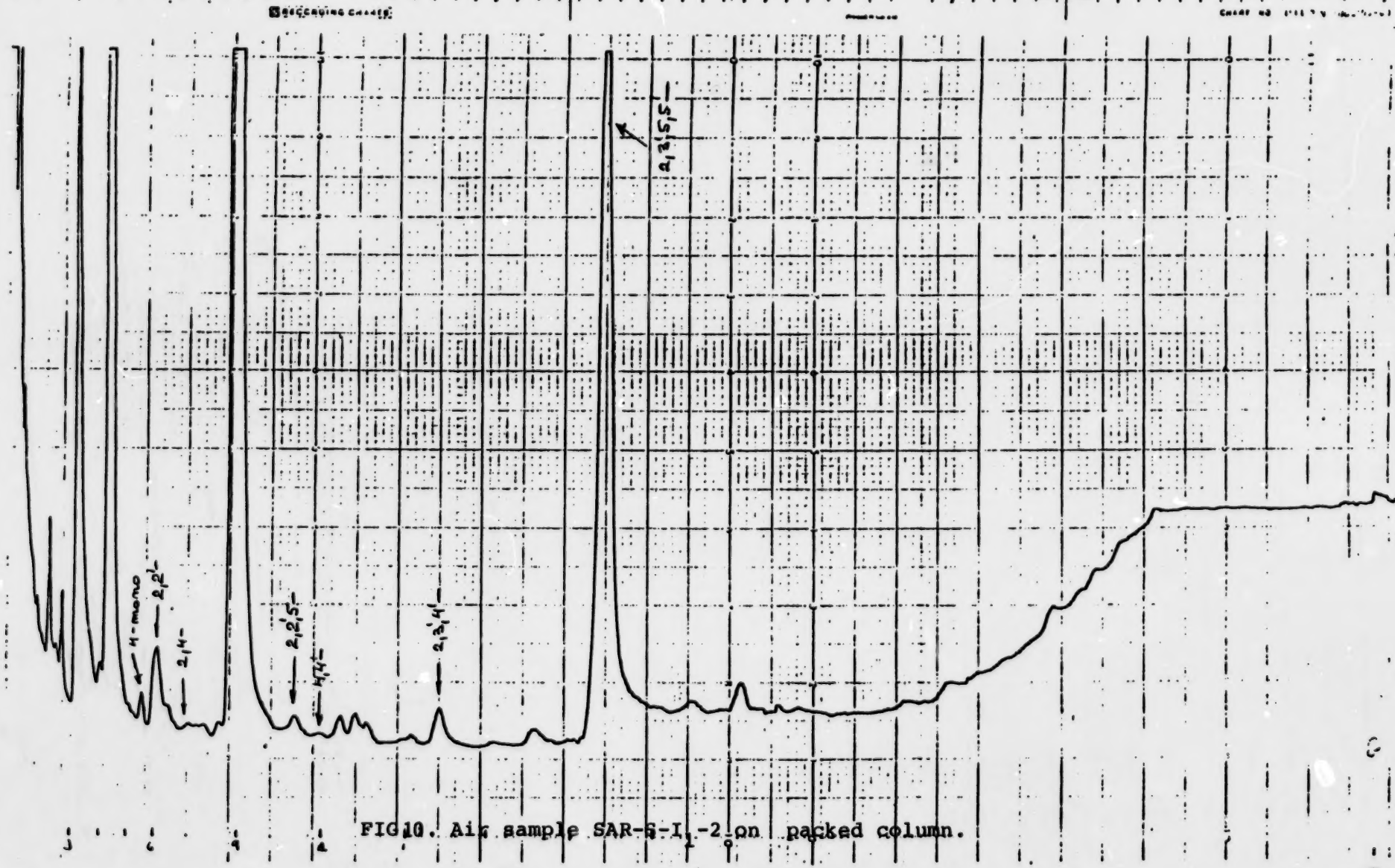


FIG 10. Air sample SAR-S-I,-2 on packed column.

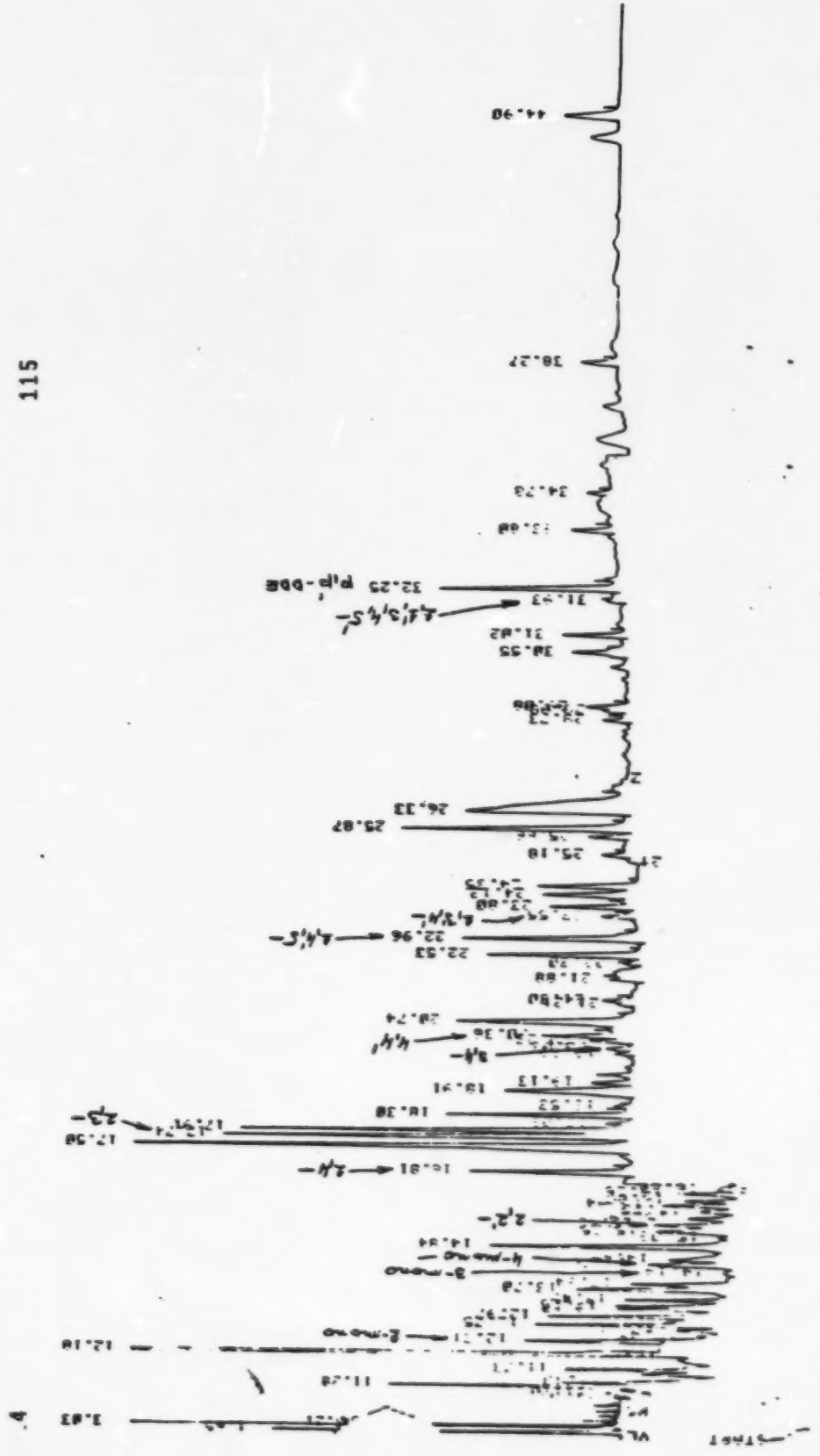


FIG. 11. Air sample LON-S-S_1-18 on capillary column

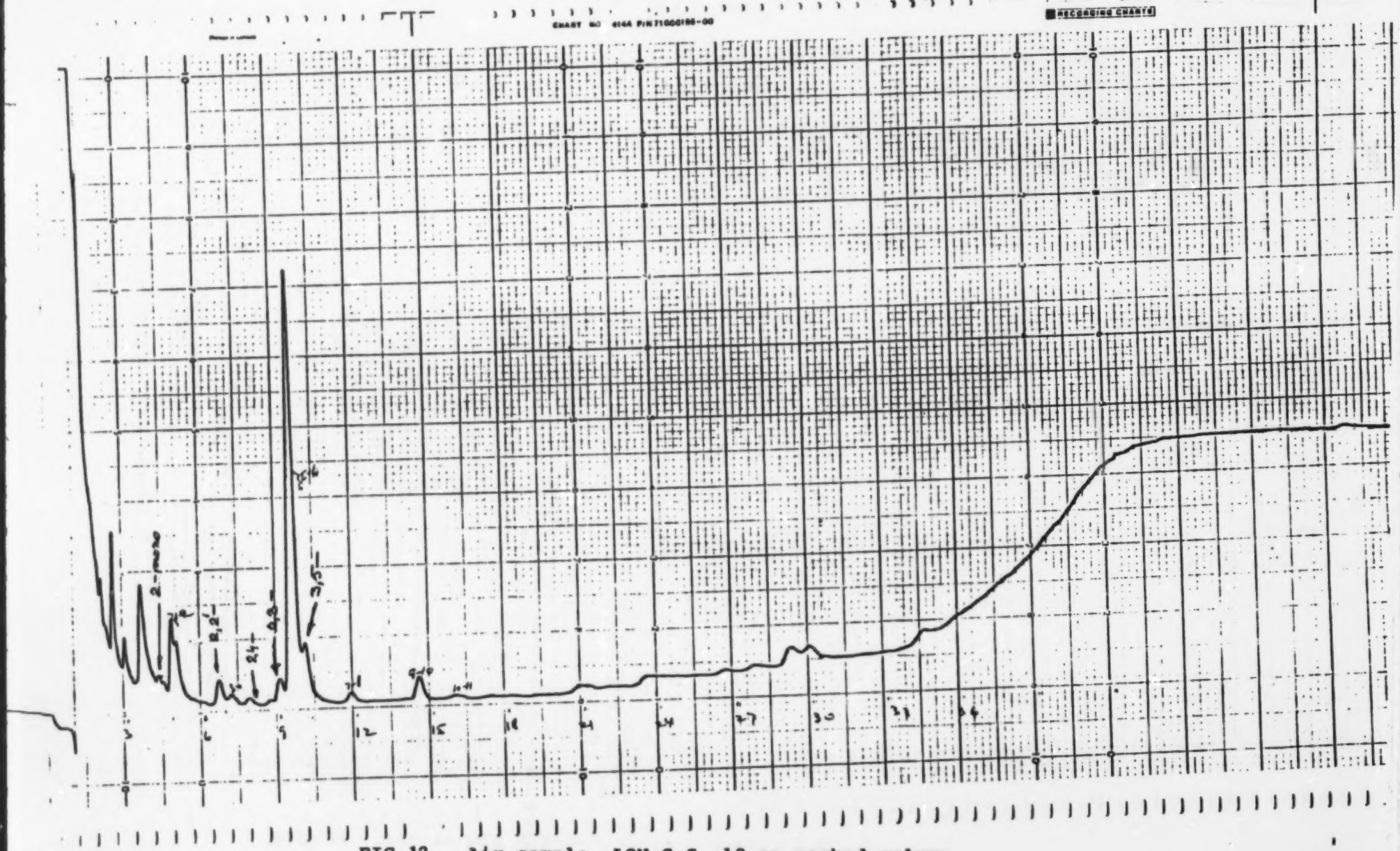


FIG. 12. Air sample LON-S-S_1-18 on packed column.

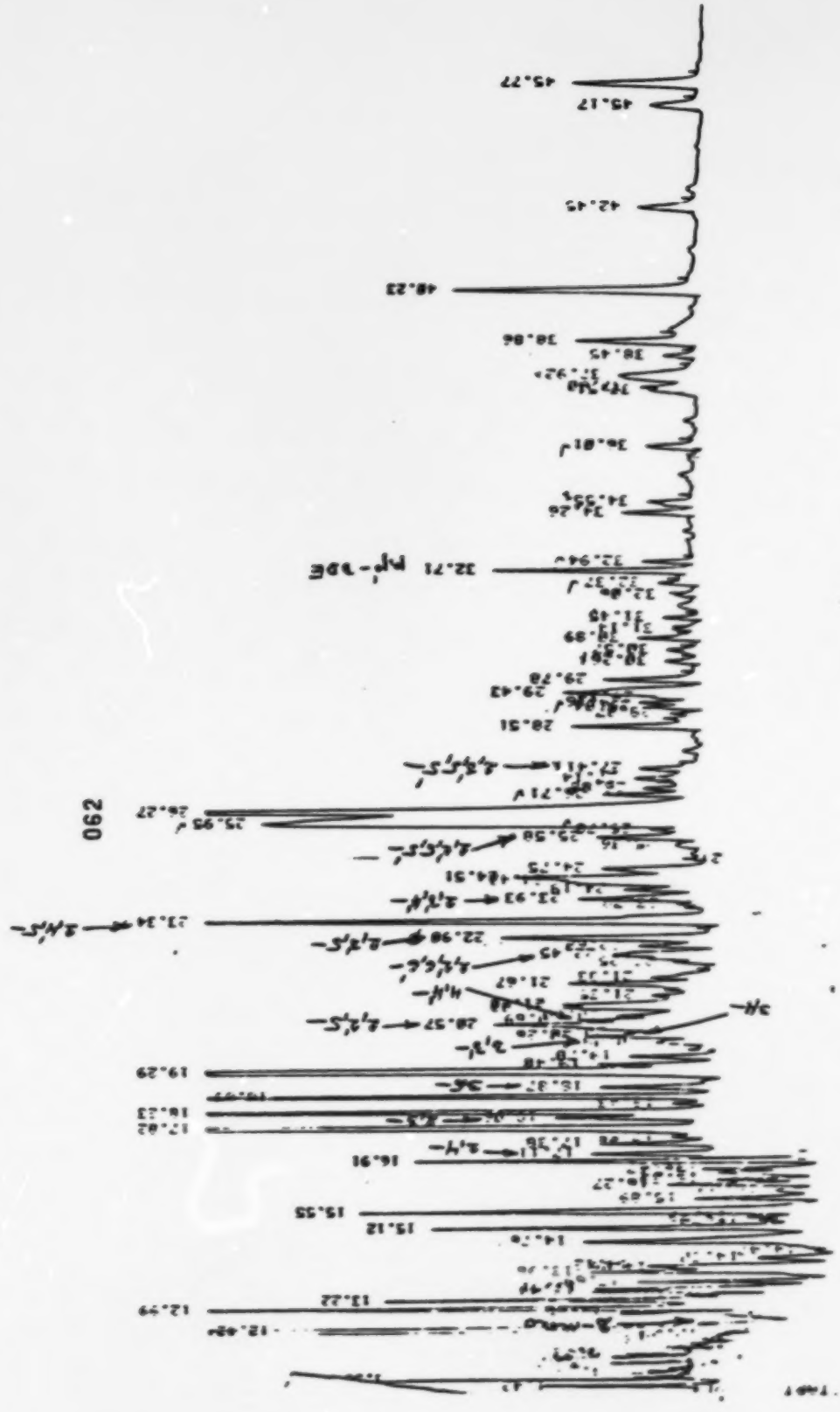


FIG.13. Air sample HAM-S-I_1-1 on capillary column.

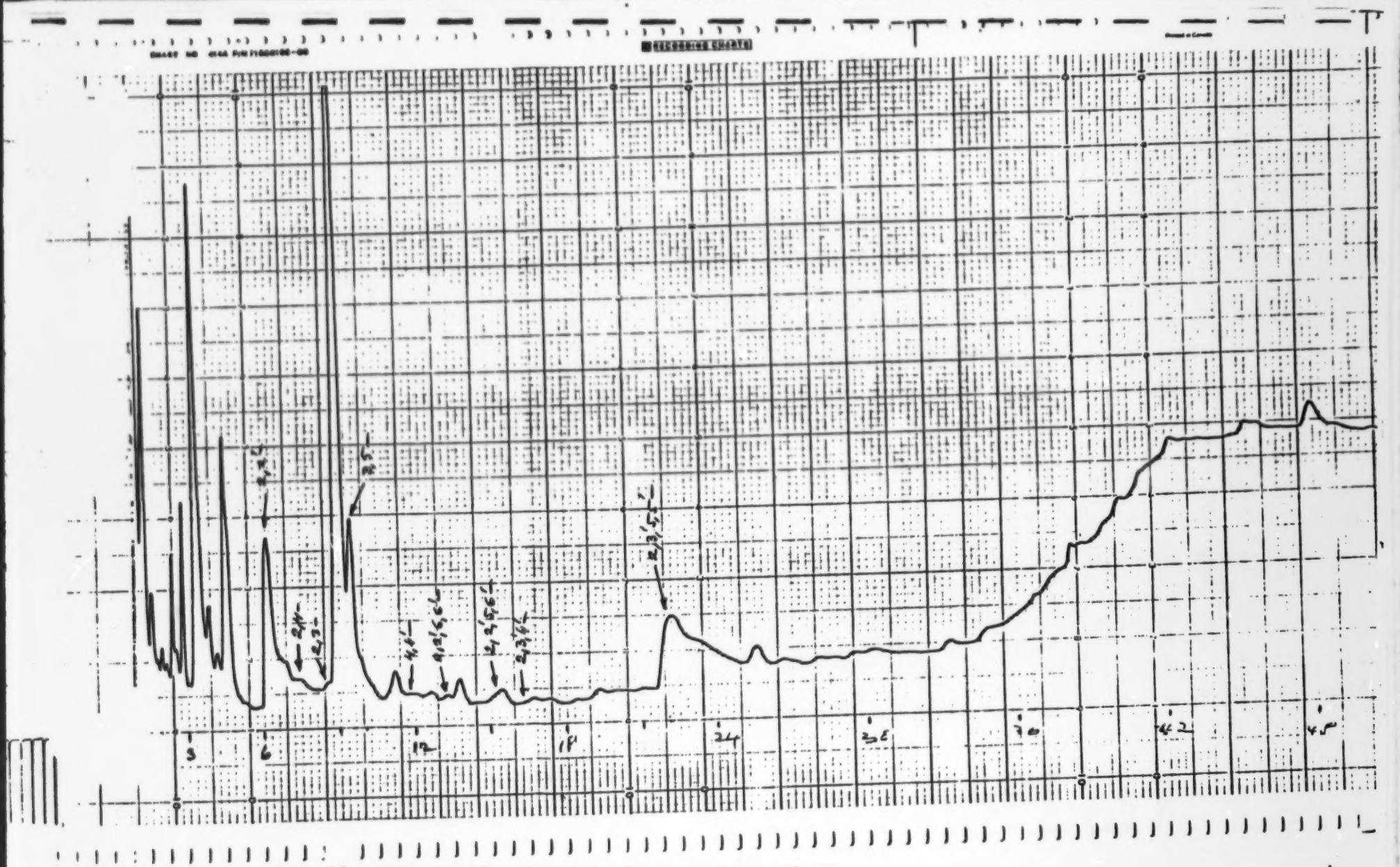


FIG. 14. Air sample HAM-S-I_1-1 on packed column.

APPENDIX A

SITE # TOR - S - U1

Concentration ng/ml

Sample No.	Assigned	Manually Assigned	Total
1	- 75.7	- 46.7	- 122.4
2	- 39.2	- 516.2	- 555.4
3	- 146.7	- 1228.2	-1374.9
4	-	-	-
5	- 71.1	- 365.1	- 436.2
6	-	-	-
7	- 73.1	- 192.6	- 265.6
8	- 42.5	- 563.2	- 605.7
9	- 58.1	- 390.9	- 449.0
10	- 29.0	- 518.4	- 547.4
11	- 22.5	- 307.2	- 329.7
12	- 13.7	- 242.1	- 255.8
13	- 25.2	- 544.3	- 569.5
14	-	-	-
15	- 77.9	- 506.2	- 583.1
16	- 0.2	- 6.6	- 6.8
17	- 1.2	- 12.9	- 14.1
18	- 41.1	- 288.2	- 329.4
19	- 4.9	- 128.9	- 133.8
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	- 4.1	- 58.2	- 62.3
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	-	-	-
B6	-	-	-
B7	-	-	-
B8	-	-	-

SITE # TOR - S - S1

Concentraion ng/ml

Sample No.	Assigned	Manually Assigned	Total
1	-	-	-
2	- 270.1	- 1455.	- 1725.
3	- 321.7	- 1405.3	- 1727.0
4	- 75.00	- 918.4	- 993.4
5	- 39.0	- 661.3	- 700.4
6	-	-	-
7	-	-	-
8	- 54.6	- 276.7	- 331.3
9	-	-	-
10	- 25.6	- 428.0	- 453.6
11	- 4.3	- 292.6	- 296.9
12	- 6.0	- 205.3	- 211.3
13	- 37.1	- 407.4	- 444.5
14	-	-	-
15	- 71.7	- 792.7	- 864.4
16	- 64.9	- 498.2	- 563.1
17	- 1.0	- 288.0	- 289.0
18	- 0.8	- 159.0	- 159.8
19	- 1.2	- 187.4	- 188.6
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	- 3.5	- 200.8	- 204.3
B3	-	-	-
B4	-	-	-
B5	- 0.15	- 0.19	- 0.34
B6	-	-	-
B7	-	-	-
B8	-	-	-

SITE # OSH - S - U1

Concentration ng/ml

Sample	Assigned	Manually Assigned	Total
1	- 122.2	- 622.4	- 744.6
2	- 110.2	- 1147.3	- 1257.5
3	-	-	-
4	- 61.6	- 553.7	- 615.3
5	- 105.4	- 1087.4	- 1193.
/6	-	-	-
7	-	-	-
8	- 43.4	- 563.4	- 606.8
9	-	-	-
10	- 39.6	- 428.1	- 467.7
11	- 12.3	- 267.7	- 279.9
12	- 2.8	- 239.0	- 241.8
13	- 26.6	- 140.2	- 166.8
14	-	-	-
15	- 123.1	- 530.6	- 653.7
16	-	-	-
17	- 0.2	- 104.7	- 104.9
18	- 30.7	- 150.9	- 181.6
19	- 22.8	- 26.1	- 48.9
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	- 0.4	- 34.3	- 34.7
B4	-	-	-
B5	- 0.01	- 0.33	- 0.34
B6	- 9.97	- 13.2	- 22.9
B7	-	-	-
B8	-	-	-

SITE # MIS - S - U1

Concentration ng/ml

Sample No.	Assigned	Manually Assigned	Total
1	- 133.5	- 115.5	- 249.0
2	- 90.3	- 1250.8	- 1341.1
3	- 81.2	- 944.7	- 1025.9
4	- 175.1	- 787.8	- 962.9
5	- 174.2	- 1031.	- 1205.
6	-	-	-
7	-	-	-
8	- 30.2	- 517.8	- 548.0
9	-	-	-
10	- 39.4	- 399.6	- 439.0
11	- 0.0	- 196.8	- 196.8
12	- 12.0	- 222.8	- 234.8
13	- 21.2	- 230.3	- 251.5
14	-	-	-
15	- 25.3	- 328.7	- 354.0
16	- 4.2	- 226.5	- 230.5
17	- 0.8	- 231.5	- 232.3
18	- 1.7	- 121.5	- 123.2
19	- 17.8	- 53.8	- 71.6
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	-	-	-
B6	- 0.4	- 0.5	- 0.9
B7	-	-	-
B8	-	-	-

SITE # MIS - S - U2

Concentration ng/ml

Sample No.	Assigned	Manually Assigned	Total
1	- 43.2	- 751.1	- 794.3
2	- 165.3	- 1416.8	- 1582.1
3	- 491.9	- 1234.4	- 1726.3
4	- 85.6	- 435.7	- 521.3
5	- 87.9	- 53.2	- 141.1
6	-	-	-
7	-	-	-
8	- 51.8	- 631.3	- 683.1
9	-	-	-
10	-	-	-
11	-	-	-
12	- 11.5	- 240..2	- 251.7
13	- 15.9	- 323.1	- 339.0
14	-	-	-
15	- 58.6	- 572.0	- 530.6
16	- 1.9	- 406.1	- 408.0
17	- 0.6	- 126.9	- 127.5
18	- 1.1	- 222.2	- 223.3
19	- 19.1	- 79.3	- 98.4
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	- 2.5	- 59.6	- 62.1
B6	- 0.1	- 25.4	- 25.5
B7	-	-	-
B8	-	-	-

SITE # MIS -S - U3

Concentration ng/ml

Sample No.	Assigned	Manually Assigned	Total
/1	- 107.2	- 532.6	- 639.8
2	- 112.6	- 71.8	- 184.4
3	- 131.1	- 1031.5	- 1162.6
4	- 144.5	- 671.8	- 816.3
5	- 236.2	- 820.8	- 1057.0
6	-	-	-
7	-	-	-
8	- 38.7	- 457.7	-496.4
9	-	-	-
10	- 41.5	- 411.3	- 452.8
11	- 21.	-	-
12	- 17.5	- 315.0	- 332.5
13	- 22.3	- 339.3	- 361.6
14	-	-	-
15	- 48.7	- 110.0	- 158.7
16	- 24.8	- 269.1	- 293.9
17	- 22.8	- 246.7	- 269.5
18	- 3.9	- 66.3	- 70.2
19	- 22.0	- 249.2	- 271.2
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	-	-	-
B6	- 0.9	- 12.6	- 13.5
B7	-	-	-
B8	-	-	-

SITE # MIS-S-U4
Concentrationng/ml

Sample No.	Assigned	Manually Assigned	Total
1	-	-	-
2	- 132.9	- 1181.6	- 1314.5
3	- 107.2	- 693.9	- 801.1
4	- 46.5	- 136.7	- 183.2
5	- 348.4	- 198.1	- 546.5
6	-	-	-
7	- 18.8	- 613.2	- 632.0
8	- 58.6	- 385.7	- 444.3
9	-	-	-
10	- 46.4	- 451.5	- 497.9
11	- 12.0	- 295.7	- 307.7
12	- 22.8	- 448.4	- 471.2
13	- 30.0	- 247.1	- 277.1
14	-	-	-
15	- 41.1	- 395.4	- 436.5
16	- 37.7	- 79.6	- 117.3
17	- 8.8	- 70.3	- 79.1
18	- 8.9	- 449.4	- 458.3
19	- 5.7	- 73.0	- 78.7
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	- 106.6	- 768.8	- 875.4
B4	-	-	-
B5	-	-	-
B6	-	-	-
B7	- 12.2	- 109.3	- 121.5
B8	-	-	-

SITE# K1N-S-U1

Concentration ng/ml

Sample No.	Assigned	Manually Assigned	Total
1	- 37.6	- 321.7	- 359.3
2	- 0.2	- 25.6	- 25.8
3	- 18.1	- 241.8	- 259.9
4	- 8.0	- 317.2	- 325.2
5	- 42.5	- 246.7	- 289.2
6	-	-	-
7	-	-	-
8	- 3.7	- 193.4	- 196.1
9	-	-	-
10	- 7.6	- 165.8	- 173.4
11	- 7.8	- 163.	- 171.2
12	- 10.6	- 155.0	-165.6
13	- 19.9	- 279.1	- 299.0
14	-	-	-
15	- 19.0	- 230.9	- 249.9
16	-	-	-
17	- 2.1	- 223.1	- 225.2
18	- 1.8	- 42.4	- 44.2
19	- 10.8	- 44.3	- 55.1
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	-	-	-
B6	- 12.8	- 67.9	- 80.7
B7	-	-	-
B8	-	-	-

Site # BUR-S-U1

Concentration ng/ml

Sample No.	Assigned	Manually Assigned	Total
1	- 38.8	- 261.2	- 300.0
2	- 150.7	- 1089.1	- 1239.8
3	-	-	-
4	- 183.8	- 1124.0	- 1308.0
5	- 107.3	- 792.2	- 899.5
6	-	-	-
7	-	-	-
8	- 20.8	- 516.1	- 536.9
9	-	-	-
10	-	-	-
11	- 13.8	- 320.7	- 334.5
12	-	-	-
13	- 10.2	- 449.4	- 459.6
14	-	-	-
15	- 131.1	- 688.7	- 819.8
16	- 70.0	- 477.8	- 547.8
17	- 2.8	- 238.2	- 241.0
18	- 4.0	- 221.2	- 225.2
19	- 8.0	- 21.9	- 29.9
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	- 3.2	- 63.9	- 67.1
B6	-	-	-
B7	-	-	-
B8	-	-	-

SITE HAM-S-I1

Concentration ng/ml

Sample No.	Assigned	Manually Assigned	Total
1	- 657.1	- 1318.6	- 1975.7
2	- 128.3	- 1093.2	- 1221.5
3	- 221.7	- 1039.0	- 1260.7
4	- 181.3	- 921.3	- 1102.6
5	- 72.0	- 249.2	- 321.2
6	-	-	-
7	- 214.5	- 486.9	- 701.4
8	- 18.6	- 41.6	- 60.2
9	- 611.0	- 1438.9	- 2049.9
10	- 262.7	- 508.5	- 771.2
11	- 23.8	- 261.7	- 285.5
12	- 79.7	- 319.6	- 399.3
13	- 11.8	- 284.9	- 296.7
14	-	-	-
15	- 389.5	-	-
16	- 327.3	- 349.5	- 676.8
17	- 9.5	- 373.9	- 383.4
18	- 181.5	- 104.2	- 285.7
19	- 161.6	- 366.7	- 528.3
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	- 0.0	- 10.4	- 10.4
B6	-	-	-
B7	-	-	-
B8	-	-	-

SITE# HAM-S-I2

Concentration ng/ml

Sample No.	Assigned	Manually Assigned	Total
1	-	-	-
2	- 161.9	- 1086.2	- 1248.1
3	- 188.3	- 883.2	- 1071.5
4	- 99.5	- 415.4	- 514.9
5	- 429.5	- 772.4	- 1201.9
6	-	-	-
7	-	-	-
8	- 93.5	- 590.4	- 683.9
9	-	-	-
10	- 48.2	- 448.6	- 496.8
11	- 20.5	- 280.9	- 301.5
12	- 55.5	- 369.4	- 424.9
13	- 8.1	- 247.8	- 255.9
14	-	-	-
15	- 120.80	- 391.50	- 512.3
16	- 3.1	- 353.4	- 356.5
17	- 0.4	- 297.0	- 297.4
18	- 27.3	- 25.3	- 52.6
19	- 104.6	- 273.0	- 377.6
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	- 0.1	- 36.6	- 36.7
B6	- 0.0	- 0.0	- 0.0
B7	-	-	-
B8	-	-	-

SITE# HAM-S-U1

Concentration ng/ml

Sample No.	Assigned	Manually Assigned	Total
1	- 63.5	- 478.9	- 542.4
2	- 149.5	- 1060.5	- 1210.0
3	-	-	-
4	- 61.9	- 472.4	- 534.3
5	- 375.2	- 1146.4	- 1522.
6	-	-	-
7	-	-	-
8	- 62.9	- 603.4	- 666.3
9	-	-	-
10	- 32.2	- 485.4	- 517.6
11	- 31.8	- 325.1	- 356.9
12	- 25.2	- 259.0	- 284.2
13	- 76.3	- 499.1	- 575.4
14	-	-	-
15	- 80.1	- 541.8	- 621.9
16	- 46.5	- 323.3	- 369.8
17	-	-	-
18	- 6.0	- 21.8	- 27.8
19	-	-	-
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	- 7.4	- 0.0	- 7.4
B6	-	-	-
B7	-	-	-
B8	-	-	-

SITE # HAM-S-U2

Concentration ng/ml

Sample No.	Assigned	Manually Assigned	Total
1	- 175.8	- 667.8	- 843.6
2	- 164.1	- 735.7	- 899.8
3	-	-	-
4	- 122.4	- 715.8	- 838.2
5	- 113.2	- 702.9	- 816.1
6	-	-	-
7	-	-	-
8	- 69.4	- 596.7	- 666.1
9	-	-	-
10	-	-	-
11	-	-	-
12	- 25.3	- 120.4	- 145.7
13	- 27.3	- 604.8	- 632.1
14	-	-	-
15	-	-	-
16	- 48.9	- 137.5	- 186.4
17	- 30.4	- 170.1	- 200.5
18	- 7.69	- 138.2	- 145.9
19	-	-	-
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	- 0.11	- 20.95	- 21.06
B6	-	-	-
B7	-	-	-
B8	-	-	-

SITE # STC-S-R1

Concentration ng/ml

Sample No.	Assigned	Manually Assigned	Total
1	- 111.4	- 344.7	- 456.1
2	-	-	-
3	-	-	-
4	- 81.6	- 421.7	- 503.3
5	- 111.3	- 780.6	- 891.9
6	-	-	-
7	-	-	-
8	- 18.0	- 70.1	- 88.1
9	-	-	-
10	- 11.2	- 412.8	- 424.0
11	- 0.7	- 370.3	- 371.0
12	- 15.4	- 216.6	- 232.0
13	- 7.4	- 290.7	- 298.1
14	-	-	-
15	-	-	-
16	-	-	-
17	- 9.5	- 77.0	- 86.5
18	- 6.2	- 161.6	- 167.8
19	-	-	-
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	- 0.61	- 16.8	- 17.4
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	- 2.3	- 115.9	- 118.2
B6	- 3.2	- 23.2	- 26.4
B7	-	-	-
B8	-	-	-

SITE # NAN-S-R1

Concentration ng/ml

Sample No.	Assigned	Manually Assigned	Total
1	- 29.4	- 407.1	- 436.5
2	- 21.6	- 319.7	- 341.3
3	- 40.3	- 541.1	- 581.4
4	- 43.9	- 327.7	- 371.6
5	- 30.9	- 136.3	- 167.2
6	-	-	-
7	-	-	-
8	- 29.8	- 493.8	- 523.6
9	- 23.7	- 258.9	- 282.6
10	- 15.4	- 184.2	- 199.6
11	- 2.4	- 215.0	- 217.4
12	- 2.7	- 195.2	- 197.9
13	- 4.3	- 201.9	- 206.2
14	-	-	-
15	- 0.2	- 414.6	- 414.8
16	- 1.4	- 181.8	- 183.2
17	- 3.1	- 214.7	- 217.8
18	- 0.0	- 261.3	- 261.3
19	-	-	-
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	- 0.1	- 31.1	- 31.2
B6	-	-	-
B7	-	-	-
B8	-	-	-

SITE # NAN-S-R2

Concentraion ng/ml

Sample No.	Assigned	Manually Assigned	Total
1	- 98.0	- 445.6	- 543.6
2	- 22.1	- 138.3	- 160.5
3	-	-	-
4	- 120.2	- 379.6	- 499.8
5	- 234.5	- 734.8	- 969.3
6	-	-	-
7	-	-	-
8	- 28.4	- 507.6	- 536.0
9	-	-	-
10	-	-	-
11	- 15.7	- 210.7	- 226.4
12	- 13.6	- 274.6	- 288.2
13	- 6.0	- 297.7	- 303.7
14	-	-	-
15	- 47.9	- 196.7	- 244.6
16	- 4.1	- 241.3	- 245.4
17	- 2.6	- 217.4	- 220.0
18	- 31.5	- 30.3	- 61.8
19	-	-	-
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	- 3.6	- 87.3	- 90.9
B2	- 0.3	- 30.0	- 30.3
B3	-	-	-
B4	-	-	-
B5	-	-	-
B6	- 0.6	- 42.8	- 43.4
B7	-	-	-
B8	-	-	-

SITE # THU-S-U1

Concentration ng/ml

Sample No.	Assigned	Manualy Asigned	Total
1	-	-	-
2	- 6.5	- 150.2	- 156.8
3	- 51.8	- 374.6	- 426.4
4	- 74.0	- 490.0	- 564.0
5	- 46.3	- 273.6	- 319.9
6	- 22.1	- 210.4	- 232.5
7	-	-	-
8	- 41.9	- 365.4	- 407.3
9	- 40.2	- 358.6	- 398.8
10	- 18.7	- 247.6	- 266.3
11	- 22.2	- 253.7	- 275.9
12	- 14.5	- 171.8	- 186.3
13	- 38.6	- 350.1	- 388.7
14	-	-	-
15	- 11.5	- 389.9	- 401.4
16	- 1.1	- 196.1	- 197.2
17	- 86.2	- 208.5	- 294.7
18	- 6.0	- 71.3	- 77.3
19	-	-	-
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	-	-	-
B6	- 0.4	- 23.0	- 23.4
B7	-	-	-
B8	-	-	-

SITE # THU-S-R1

Concentration ng/ml

Sample No.	Assigned	Manually	Total
1	-	-	-
2	-	-	-
3	- 26.1	- 219.4	- 245.5
4	- 2.3	- 209.3	- 211.6
5	- 8.7	- 404.0	- 412.7
6	- 0.1	- 138.1	- 138.2
7	-	-	-
8	-	-	-
9	- 19.5	- 355.1	- 374.6
10	- 2.2	- 258.6	- 260.8
11	- 2.2	- 226.8	- 229.0
12	- 9.4	- 234.7	- 244.1
13	- 5.4	- 233.2	- 238.6
14	-	-	-
15	- 1.9	- 153.9	- 155.8
16	- 5.5	- 180.7	- 186.2
17	- 8.4	- 250.0	- 258.4
18	- 0.9	- 150.1	- 151.0
19	-	-	-
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	- 7.2	- 168.9	- 176.1
B3	-	-	-
B4	-	-	-
B5	-	-	-
B6	-	-	-
B7	-	-	-
B8	-	-	-

SITE # WIN-S-U1

Concentration ng/ml

Sample	Assigned	Manually Assigned	Total
1	-	-	-
2	- 68.5	- 447.5	- 516.0
3	-	-	-
4	- 111.1	- 594.9	- 706.0
5	- 112.4	- 688.3	- 800.7
6	-	-	-
7	-	-	-
8	- 98.6	- 670.4	- 769.0
9	- 169.3	- 477.3	- 646.6
10	- 6.7	- 394.2	- 400.9
11	- 88.7	- 401.0	- 489.6
12	-	-	-
13	- 21.7	- 343.3	- 365.0
14	-	-	-
15	- 197.2	- 335.6	- 532.8
16	-	-	-
17	- 67.7	- 201.8	- 269.5
18	- 10.4	- 25.2	- 35.6
19	-	-	-
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	-	-	-
B6	-	-	-
B7	-	-	-
B8	-	-	-

SITE # SUD-S-S1

Concentration ng/ml

Samples No.	Assigned	Manually Assigned	Total
1	- 33.7	- 326.0	- 359.7
2	-	-	-
3	- 22.1	- 264.7	- 286./8
4	- 38.8	- 204.1	- 242.9
5	- 12.7	- 378.8	- 391.5
6	- 15.7	- 164.9	- 180.6
7	-	-	-
8	- 34.2	- 291.6	- 325.8
9	-	-	-
10	- 2.5	- 353.3	- 355.8
11	- 5.0	- 245.3	- 250.3
12	- 9.1	- 137.2	- 146.3
13	- 27.4	- 251.4	- 278.8
14	-	-	-
15	- 27.7	- 136.1	- 163.8
16	- 120.7	- 307.0	- 427.7
17	- 31.8	- 241.4	- 273.2
18	- 5.3	- 266.9	- 272.2
19	-	-	-
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	- 0.4	- 14.8	- 15.2
B6	-	-	-
B7	-	-	-
B8	-	-	-

SITE # SUD-S-R1

Concentration ng/ml

Sample No	Assigned	Manually Assigned	Total
1	- 49.7	- 398.2	- 447.9
2	- 25.7	- 465.2	- 490.9
3	- 23.3	- 361.1	- 384.4
4	- 24.0	- 139.7	- 163.7
5	- 28.4	- 184.9	- 213.3
6	- 2.5	- 132.5	- 135.0
7	-	-	-
8	- 20.7	- 340.4	- 361.1
9	-	-	-
10	- 2.4	- 126.2	- 128.6
11	- 9.8	- 212.5	- 222.3
12	- 3.2	- 112.7	- 115.9
13	- 14.1	- 257.8	- 271.9
14	-	-	-
15	- 0.0	- 136.1	- 136.1
16	- 0.0	- 235.5	- 235.5
17	- 6.0	- 123.0	- 129.0
18	- 1.3	- 15.1	- 16.4
19	-	-	-
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	- 9.7	- 63.1	- 72.8
B6	-	-	-
B7	-	-	-
B8	-	-	-

SITE # LON-S-S1

Concentration ng/ml

Sample No.	Assigned	Manually Assigned	Total
1	-	-	-
2	-	-	-
3	-	-	-
4	- 32.7	- 89.6	- 122.3
5	- 32.0	- 517.4	- 549.4
6	- 11.0	- 386.3	- 397.3
7	-	-	-
8	- 45.4	- 354.0	- 399.4
9	-	-	-
10	- 12.0	- 300.3	- 312.3
11	- 50.9	- 362.0	- 412.9
12	- 34.7	- 380.1	- 414.8
13	- 54.3	- 586.4	- 640.7
14	-	-	-
15	- 0.2	- 99.7	- 99.9
16	-	-	-
17	- 28.1	- 588.3	- 616.4
18	- 32.6	- 186.6	- 219.2
19	-	-	-
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	-	-	-
B6	-	-	-
B7	-	-	-
B8	-	-	-

SITE # SAR-S-I1

Concentration ng/ml

Sample No.	Assigned	Manually Assigned	Total
1	- 99.6	- 16273.5	- 16373.1
2	- 267.8	- 9803.	- 10071
3	- 181.5	- 6246.	- 6427
4	- 110.5	- 1567.	- 1677
6	-	-	-
7	-	-	-
8	- 100.1	- 1500.7	- 1600.8
9	- 66.3	- 34.5	- 100.8
10	- 102.8	- 1507.3	- 1610.08
11	-	-	-
12	- 71.1	- 151.8	- 222.9
13	-	-	-
14	-	-	-
15	- 175.9	- 1560.	- 1736.
16	- 109.9	- 649.7	- 759.6
17	- 53.7	- 350.5	- 404.2
18	- 118.2	- 240.4	- 358.6
19	-	-	-
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	-	-	-
B6	-	-	-
B7	-	-	-
B8	-	-	-

SITE # SAR-S-U1

Cocnentration ng/ml

Sample No.	Assigned	Manually Assigned	Total
1	- 169.5	- 1688.	- 1858.
2	-	-	-
3	- 86.4	- 1705.4	- 1791.7
4	- 35.1	- 621.1	- 656.2
5	- 73.8	- 205.0	- 278.8
6	- 54.5	- 83.0	- 137.5
7	-	-	-
8	- 74.1	- 992.4	- 1066.5
9	-	-	-
10	- 49.0	- 650.0	- 699.0
11	- 26.8	- 53.3	- 80.0
12	- 28.0	- 369.0	- 397.0
13	- 43.8	- 470.1	- 513.9
14	-	-	-
15	- 123.4	- 497.3	- 620.7
16	- 33.8	- 252.8	- 286.6
17	- 21.6	- 82.1	- 103.7
18	- 1.7	- 33.3	- 35.0
19	-	-	-
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	-	-	-
B2	-	-	-
B3	-	-	-
B4	-	-	-
B5	-	-	-
B6	-	-	-
B7	-	-	-
B8	-	-	-

SITE # MOO-S-R1

Concentration ng/ml

Sample No.	Assigned	Manually Assigned	Total
1	-	-	-
2	- 64.0	- 479.0	- 543.0
3	- 0.0	- 0.0	- 0.0
4	- 22.2	- 170.1	- 192.3
5	- 40.4	- 227.1	- 267.5
6	- 39.6	- 272.9	- 312.5
7	-	-	-
8	- 10.0	- 177.5	- 187.5
9	-	-	-
10	- 2.5	- 309.3	- 311.8
11	- 22.7	- 82.3	- 105.0
12	- 17.4	- 134.0	- 151.3
13	- 6.6	- 269.8	- 276.4
14	-	-	-
15	-	-	-
16	- 0.0	- 145.6	- 145.6
17	- 1.1	- 469.7	- 470.8
18	- 43.8	- 113.3	- 157.1
19	-	-	-
20	-	-	-
21	-	-	-
22	-	-	-
23	-	-	-
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
B1	- 9.5	- 12.2	- 21.7
B2	-	-	-
B3	- 0.5	- 137.7	- 138.2
B4	-	-	-
B5	-	-	-
B6	-	-	-
B7	-	-	-
B8	-	-	-